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EDITED BY

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ERRATA.

p. 144, l. 21 from foot: after *from* insert *Eoliths*.
p. 159, l. 2 from foot: for "two lower" read "lower two."
p. 400, note 2, l. 5: for "Weymouth" read "Weybourne."
p. 513, l. 22: for "are" read "is."

Yours very truly

J. McKenny Hughes

THE

GEOLOGICAL MAGAZINE.

NEW SERIES. DECADE V. VOL. III.

No. I.—JANUARY, 1906.

ORIGINAL ARTICLES.

I.—Eminent Living Geologists:

THOMAS McKENNY HUGHES, M.A., F.R.S., F.G.S., F.S.A.,

Woodwardian Professor of Geology in the University of Cambridge;
of Trinity College, Cambridge; Professorial Fellow of Clare College, Cambridge;
Chevalier of the Order SS. Maurice et Lazarus, Italia;
Corr. Memb. Geol. Soc. Belgium, France, Germany, Italy, etc.

(WITH A PORTRAIT, PLATE I.)

AMONG the great body of geologists, who are justly entitled by their work in this field of science to rank as "knights-commanders of the hammer," there is no one more distinguished, as well for his active services as for the geniality of his disposition and his bonhomie, than the amiable and accomplished occupant of the Woodwardian Chair of Geology in the University of Cambridge, Professor T. McKenny Hughes.

He was born at Aberystwyth, in Wales, and is the son of that most famous and popular Bishop of St. Asaph (1807–1889) well known as a prelate who preached and talked to his people fluently in Welsh, and was beloved by all in his diocese accordingly. Mr. T. McKenny Hughes is also brother of the present Bishop of Llandaff, and a grandson of Sir Thomas McKenny, Bart., who took a very prominent part in promoting Catholic emancipation and similar movements in Ireland.

Spending much of his early days in the Principality, Mr. Hughes naturally acquired a thorough knowledge of Welsh, and has never ceased to cherish a love for the Cambrian mountains and valleys of his native land, where he also imbibed from association much of the happy disposition and quickness of mode characteristic of the Welsh people, together with their love of music and anecdote. His early education was acquired at Leamington and Llandovery Colleges, whence he afterwards entered at Trinity College, Cambridge, in 1853. While an undergraduate he was an associate of the Ray

Club, and a constant attendant at Professor Sedgwick's lectures in the Woodwardian Museum. After taking his Bachelor's degree in 1857, he was engaged in tuition for two years, during which his geological tendencies were for the time in abeyance. Mr. Hughes did not proceed to take his M.A. degree until ten years later, in 1867.

At the commencement of the year 1860 a new career seemed to be opening to Mr. Hughes, when he received the appointment of Secretary to Mr. (afterwards Sir) C. T. Newton, K.C.B., H.B.M. Consul in Rome, where later in that year, and in 1861, Mr. Hughes was left in charge as Acting-Consul. During his residence in Rome he took the opportunity to study the sub-Apennine formations on the hills around the Eternal City, and made collections of fossils from them, and also from the more recent deposits of the Valley of the Tiber.

One of the most interesting episodes in his life was when he was left Acting-Consul in Rome in 1860 and 1861, when Garibaldi was marching on the city and all sorts of mercenaries were collected to meet him. Among them was a brigade of Irishmen, who gave more trouble to the Papal officers themselves than to the enemy. He was often called in to help to arrange matters *officieusement* between the officers and their men, who could not understand one another's language. This kind of training abroad gave him an experience in dealing with men which he has found useful ever since.

In 1861 he had the option of accompanying Lord Odo Russell to Berlin, and at the same time he received an invitation from Sir Roderick Murchison to join the staff of the Geological Survey of Great Britain. In this "meeting of the waters" his love for geology prevailed, he bade adieu to Rome, and to what seemed to promise in the future a brilliant diplomatic career, and he returned to England as a "Royal hammerer."

Accordingly we find Mr. Hughes later on in 1861 duly installed as an Assistant Geologist on the Geological Survey of Great Britain, Sir Roderick I. Murchison being then Director-General, and Professor A. C. Ramsay, Director. He commenced work, and was occupied during several field seasons in mapping the Chalk and Lower Eocene strata along the Medway Valley, and near Faversham and Sittingbourne; and his observations on this region were published in Mr. Whitaker's Memoir on the Geology of the London Basin (Mem. Geol. Surv., vol. iv, 1872). The Chalk was then divided into broad lithological divisions, which were carefully described with regard to their local features, economic products, and leading fossils; and Mr. Hughes remarked that "from the varying character of the beds and the irregular occurrence of the layers of flints, it is very probable that the same horizon may not have been everywhere taken as the base of the Upper Chalk." Attention was called to the accumulations of chalk and flint rubble that have attracted much notice during recent years; and also to the layer of unworn green-coated flints that usually occurs at the top of the Chalk, where it is covered by the Thanet Sand. Mr. Hughes (in a paper read before

the Geological Society in 1866) gave reasons for believing that the layer was due to the dissolution of the top beds of the Chalk after the deposition of the Thanet Sand. He also dealt with Sheppey, the rapid waste of its coast, and the curious mounds in the adjacent marshes, that had been a puzzle to antiquaries, but might well be attributed to tidal action and the modifying effects of subaërial denudation. He pointed out that the Medway, below Cuxton, flows along the line of a gentle anticlinal axis in the Chalk, and he discussed the effects of denudation on the permanent water-level in the Chalk.

Working later (1865–6) in the country near Hertford and St. Albans, Mr. Hughes described the drift gravels under two heads; that of the Lower Plain, which for the most part is the ordinary mixed glacial gravel associated with the Chalky Boulder-clay, and that of the Higher Plain, consisting chiefly of pebbles of flint, quartz, etc., which he regarded as a marine deposit, and he hinted at its possible Pliocene age.

In 1866 Mr. Hughes was transferred to the Lake District where the Geological Survey had commenced operations under the superintendence of W. T. Aveline. In that region he had the satisfaction of meeting his old master, Sedgwick, on his own ground, working in the neighbourhood of Kirkby Lonsdale, Dent, and Sedbergh. There, too, he was ever a welcome guest in the country houses, and after a hard day's tramp across mountain and moor, he frequently rode many miles on horseback from his quarters to dinner or dance. His personality has always readily turned strangers into friends amongst rich and poor. Once, after a long day's work in the Crossfell country, he went into a lonely cottage and asked the good woman to give him something to eat. She did so, and when he had finished he said, "What is there to pay?" "Nowt at a', nowt at a'," she replied, "yer cumpany's good!"

He now zealously paid attention to the fossils of the Silurian and other rocks on the borders of Westmorland and Yorkshire, and his observations communicated to the Geological Magazine for 1867 led him to confirm the breach between the Upper and Lower Silurian, and to support the view of Sedgwick that the Coniston Flags formed the base of the upper division. The publication of these views was, we believe, received with some disapprobation on the part of the Director-General of the Geological Survey.

The main results of his field-work were printed subsequently in Memoirs on the geology of the neighbourhood of Kirkby Lonsdale and Kendal (written in conjunction with Mr. W. T. Aveline and Mr. R. H. Tiddeman), and on the geology of the country around Kendal, Sedbergh, Bowness, and Tebay (with W. T. Aveline).

In describing the "Upper Old Red Conglomerate" he remarked on the unfortunate introduction into the district of the term "Old Red," as the conglomerate was truly the Basement Bed of the Carboniferous Series. With reference to the Yoredale Rocks, he observed that "They thus form a kind of passage from the Mountain Limestone to the Millstone Grit, and should, perhaps, be considered

as the upper part of the Mountain Limestone split up by shales and sandstones."

In all his notes published by the Geological Survey we find careful attention paid to the work of previous observers, and many acute observations on the facts and phenomena that came before him.

It was while serving as an Assistant Geologist on the Geological Survey that the Chair of Geology in Cambridge became vacant by the death, in his 88th year, of the illustrious Professor Adam Sedgwick, on the 27th January, 1873, after occupying that position for 55 years.

By Statute of the University, the appointment must take place within one month from the vacancy being declared, so that on the 20th February, 1873, the Heads of Houses, Professors, University Examiners, and resident members of the Senate proceeded to elect a successor, no fewer than nine candidates having offered themselves for the post. Most of these, however, withdrew without going to the poll, while other candidates early retired from the contest, which finally resulted in the election of Mr. Hughes by a small majority over Professor Bonney.

Both before and after his election to the chair, Professor Hughes was intimately associated with the late Sir Charles Lyell, with whom he made several foreign and British tours. Lyell frequently mentions his friend—"Mr. T. M'K. Hughes, *now* Woodwardian Professor at Cambridge"—in the fourth edition of his "Antiquity of Man," when, in the Spring of 1872, they visited together the cave of Aurignac and the caverns of Dordogne.

As a lecturer Professor Hughes is extremely fluent and clear in his delivery, and he makes excellent use of the chalk and blackboard to aid his demonstrations. He is also a most popular man with his students and at the meetings of his fellow-workers at the Geological Society of London.

The remarkable feature of Professor Hughes' work in Cambridge has been the large number of men of mark who have studied under him, and also the very strong list of graduates who have joined the teaching staff in what is now justly recognised as "*the* Cambridge School of Geology."

We recall with pleasure some of these who have taken distinguished places in the world, and a few who have already ended their work well :—

1874.[1] Walter Keeping, M.A., Professor of Natural Science, Aberystwyth University.
1875. Robert D. Roberts, D.Sc., M.A., F.G.S., University of London, etc.
1875. Aubrey Strahan, M.A., F.R.S., Geological Survey of England and Wales.
1878. Edward B. Tawney, M.A., F.G.S., Assistant to the Woodwardian Professor.
1879. J. E. Marr, M.A., Sc.D., F.R.S., President Geol. Soc. London (Reader in Geology in the University of Cambridge).
1879. T. H. D. La Touche, M.A., Superintendent Geol. Survey of India.
1880. C. S. Middlemiss, M.A., F.G.S., Superintendent Geol. Survey of India.
1880. Arthur S. Reid, M.A., F.G.S., Trinity College, Glenalmond.
1881. W. H. Herries, B.A., F.G.S., New Zealand.

[1] The date affixed is that of the first degree taken at Cambridge. Where the date could not be ascertained, a dash is put instead of the year.—Edit. Geol. Mag.

1882. Professor W. W. Watts, M.A., M.Sc., F.R.S., Sec. Geol. Soc. London; University of Birmingham.
1882. Alfred Harker, M.A., F.R.S. [Geol. Survey of Scotland (retired)], Fellow of St. John's College, Cambridge; University Lecturer in Petrology.
1883. Rev. W. M. Lower Carter, M.A., F.G.S., Sec. Yorks. Geol. Polyt. Soc.
1883. T. Roberts, M.A., F.G.S., Assistant to the Woodwardian Professor.
1883. Evan W. Small, M.A., B.Sc.
1884. J. R. Ainsworth Davis, Professor University College, Aberystwyth.
1884. Robert S. Herries, M.A., V.P. Geol. Soc.
1886. J. W. Carr, M.A., F.L.S., F.G.S., Professor University College, Nottingham.
1886. A. C. Seward, M.A., F.R.S., F.L.S., Fellow of Emmanuel College, Cambridge; University Lecturer in Botany, Cambridge.
1886. Professor E. J. Garwood, M.A., Sec. Geol. Soc. London; Professor of Geology, University College, London.
1887. Philip Lake, M.A., F.G.S., Lecturer at Colchester College.
1888. Professor T. H. Easterfield, M.A., Wellington, New Zealand.
1888. Arthur Hutchinson, M.A., Ph.D., F.C.S., F.G.S., Demonstrator in Mineralogy in the University of Cambridge.
1888. Robert Ludwig Mond, M.A., F.R.S.E., F.G.S.
1888 (took Tripos). Marie Wilman, South African Museum, Cape Town.
1889. S. F. Dutton, M.A., H.M. Inspector of Schools.
1889. Professor T. T. Groom, M.A., D.Sc. Lond., F.G.S., University College, Reading.
1889. C. H. Hawes, M.A., traveller and author.
1889. Professor S. H. Reynolds, M.A., F.G.S., Professor of Geology, University College, Bristol.
1889. Herbert Warington Smyth, M.A., LL.M., F.G.S., Secretary to the Mines Department, Transvaal.
1890 (Classical Tripos, 1st Class). C. B. Wedd, B.A., F.G.S., Geol. Survey of England and Wales.
1890. H. Woods, M.A., F.G.S., University Lecturer in Palæozoology, Cambridge.
1891. Harry Brownsword, M.A., The Leys School, Cambridge.
1891. H. Kynaston, B.A., F.G.S., Director of the Geol. Survey of the Transvaal Colony, Pretoria.
1891. E. A. Peters, B.A., M.D.
1891. F. R. Cowper Reed, M.A., F.G.S., Assistant to the Woodwardian Professor.
1892. L. J. Spencer, M.A., F.G.S., Department of Mineralogy, British Museum (Nat. Hist.).
1893. F. L. Kitchin, M.A., Ph.D., F.G.S., Palæontologist to Geol. Survey of Great Britain.
1894. A. W. Rogers, M.A., F.G.S., Director of the Geol. Survey of Cape Colony.
1894–5. Miss Gertrude L. Elles, D.Sc., Assistant to the Woodwardian Professor; Newnham College.
1895. R. Hawthorn Kitson, B.A., F.G.S., Leeds.
1895. Miss Ethel M. R. Wood, M.Sc., Birmingham University; Newnham Coll.
1896. E. H. Cunningham-Craig, B.A., F.G.S., Geol. Survey of Scotland (temporarily of Trinidad).
1897. H. H. Thomas, M.A., F.G.S., Geol. Survey of England.
1897. H. Stanley Jevons, B.A., F.G.S., University College, Cardiff.
1898. E. A. Newell Arber, M.A., Demonstrator in Palæobotany, Geol. Mus., Cambridge.
1900. W. G. Fearnsides, M.A., F.G.S., Fellow of Sidney Sussex College, Assistant Demonstrator, Geol. Mus., Cambridge.
1901. H. T. Ferrar, M.A., F.G.S., Antarctic explorer on "Discovery"; Survey of Egypt.
1901. K. A. K. Hallowes, B.A., Assoc.R.S.M., F.G.S., Geol. Survey of India.
1901. H. B. Muff, B.A., F.G.S., Geol. Survey of Scotland.
1902. E. B. Bailey, B.A., F.G.S., Geol. Survey of Scotland.
1902. R. H. Rastall, B.A., F.G.S., Assistant Demonstrator, Geol. Mus., Cambridge.
—— F. B. Smith, B.A., Agricultural College, Africa.
—— L. W. Hinxman, B.A., Geological Survey of Scotland.
—— G. W. Grabham, B.A., F.G.S., Geol. Survey of England.
—— Owen Thomas Jones, B.A., Geol. Survey of England.

The first man who joined Professor Hughes' teaching staff, by special invitation, was the well-known geologist Mr. Edward B. Tawney. He was not a graduate of the University in the ordinary sense of the term, having taken his honours and his training at the Royal School of Mines and elsewhere. He became Professor Hughes' earliest assistant in 1878. In the Academic year following the University conferred on him the honorary degree of M.A. (*propter merita*), but he did not long survive to carry on the splendid work of teaching. He died in 1882 at the comparatively early age of 42; but he accomplished much good work in his lifetime, as may be seen by reference to his published papers.[1] Another excellent teacher, T. Roberts, M.A., followed in 1883, and continued until his death in 1892, having taken up more especially the Jurassic rocks as his line of research. Dr. J. E. Marr, M.A., F.R.S., Pres. Geol. Soc., commenced teaching in 1879, dealing specially with the older rocks, and is "Reader in Geology" in the University of Cambridge. Mr. Alfred Harker, M.A., F.R.S., has also done much valuable work in advancing the study of petrology, and in teaching the nature of rock-structures, more especially of the igneous rocks. Mr. Henry Woods, M.A., F.G.S., Lecturer on Palæozoology, deals with a branch of study pursued also by Mr. F. R. Cowper Reed, M.A., F.G.S.; the latter also takes an earnest and active part in the Museum arrangements. Miss G. L. Elles, D.Sc., has likewise assisted the Professor of Geology as a demonstrator to his classes.

With such advantages afforded them, what wonder then, if the geologists who leave the Cambridge University are so well equipped that they now mostly occupy leading positions in Museums, upon Geological Surveys, and in the teaching of the science, not only at home but in India and in our Colonies. Nor must it be forgotten (if we except the Ashmolean Museum, opened in 1683) that Cambridge had its splendid Woodwardian Museum from an earlier date even than the sister University of Oxford, although, till late, far too "cabin'd, cribb'd, and confin'd" for want of adequate exhibition space. In 1835 it was decided by the University to build a museum for geology; and the popularity of Professor Sedgwick was so great that a sum of £23,400 was readily collected by public subscription, to which was added £4,000 from the Woodwardian Trust Funds. Cockerell's Building was erected with the help of these funds, and to the geological collection the two lower floors were assigned. But this accommodation, owing to the large accessions made to the geological collections, had been obviously inadequate for many years past.

On the death of Professor Sedgwick in 1873, it was decided that the memorial to him should take the form of a new and larger Museum; and in that year a public subscription was opened for this purpose, and a sum raised which ultimately amounted to over £28,000. The public recognition of the value of geology as a subject for University teaching in Cambridge has thus been demonstrated,

[1] Geol. Mag., 1883, pp. 140–144.

upon two occasions, in a very substantial manner. A writer at the time[1] says:—"After a long series of disappointments and difficulties the indefatigable energy and perseverance of Professor Sedgwick's successor, Professor T. McKenny Hughes, have triumphed over the countless obstacles which hindered the realisation of the scheme. . . . The Architect of the building is Mr. T. G. Jackson, R.A., and he has had the difficult task of designing a museum which should satisfy the needs of the Geological Department and the requirements of the various University syndicates. . . . Whatever may be the opinion of these bodies, the staff and students have good reason to be well pleased with the ample accommodation provided for them, and the collections are now adequately exhibited in the new galleries. Research and other laboratories are provided, and the principal lecture-room is capable of accommodating a class of 120 students. Midway between the galleries for Palæozoic and Neozoic fossils stands the bronze statue of Professor Sedgwick, with his geological hammer in one hand and a slab bearing the Cambrian Trilobite *Angelina Sedgwickii* in the other."

One who graduated more than fifty years ago, and knew the old Museum in Sedgwick's lifetime, strolled into the new building in Downing Street, Cambridge, the other day, and, seeing the glories of the Museum for the first time, was heard to exclaim: "How different all this is from what it was in my time! How I envy the students and the teachers who are privileged to study and work at geology under such favourable conditions as they now enjoy! I should like to have my time over again in 1906."

Remembering the removal of the geological collections of the British Museum from Bloomsbury to South Kensington in 1880, the writer can well understand the enormous difficulties which Professor Hughes must have encountered, with only a very small staff at his command, in carrying out the task of removing the Woodwardian collections from the old building into their new home, and their subsequent rearrangement.

But we must not dwell too long upon the "Sedgwick Memorial Museum," save to refer to it as one of the great and important objects carried out by Professor Hughes in connection with the teaching of geology in the University during his term of office.

After the death of the Rev. Canon Charles Kingsley, the founder and President of the Chester Society of Natural Science, in 1875, Professor T. McKenny Hughes was elected his successor, and delivered several addresses to its members during his term of office. He received the "Kingsley Memorial Medal," established in memory of Charles Kingsley by the Chester Naturalists. Professor Hughes was likewise President of the Kendal Literary and Scientific Society.

While devoting his energies so largely to the work of the University, Professor Hughes continued to carry on field-work in various parts of the country, notably in Wales, both among the more ancient rocks and among the caves and Drift deposits. The list of

[1] Geol. Mag., 1903, pp. 532–534.

papers appended to this memoir will sufficiently indicate these labours, but we may recall attention to one subject that has since attracted a good deal of notice.

In his paper "On the Brecciated Bed in the Dimetian at St. Davids" (GEOL. MAG., 1883, p. 306), he discussed the origin of certain breccias and brecciated conglomerates in homogeneous rocks, and the breaking up and recementing of rock-masses in place. He gave a diagram of a brecciated granitoid rock near Bryngarn, composed of large and small subangular fragments, and this bed (which would now be spoken of as a "crush conglomerate") was described as "not of transport origin, but represents brecciation in place and subsequent weathering along the joint planes."

In February, 1891, Sir Archibald Geikie, F.R.S., the President of the Geological Society, announced that the Lyell Medal had been awarded by the Council to Professor T. McKenny Hughes, in appreciation of the value of his investigations in various departments of geology, especially among the older rocks. He referred particularly to Professor Hughes' researches in Caernarvonshire and Anglesey, which formed the starting-point to those later inquiries which had done so much to clear up the earlier chapters in the geological history of Wales. "You have," said the President, "not confined yourself, however, to the rocks of any one system or period, but have ranged freely from Archæan gneiss to raised beach . . . . with that happy faculty of enthusiasm which, reacting on younger minds, 'allures to older worlds and leads the way.' This medal will not only serve to mark the Society's appreciation of your work, but will also connect you by another link with the memory of our friend and master, Lyell."

Professor Hughes was elected a Fellow of the Geological Society in 1862 and a Fellow of the Royal Society in 1889.

At the meeting of the International Geological Congress held in Paris in 1878, Professor Hughes was appointed a member of the Commission for the unification of geological signs and geological nomenclature and classification. He was chosen President of the British Committee of Organisation to deal with the subjects of classification and nomenclature. Five sub-committees were formed and their reports were issued in 1885, and revised and amplified in a second edition in 1888. To the latter Professor Hughes contributed an interesting and philosophic preface on the rules which should guide us in our classification of strata, and in our descriptions of rocks, fossils, and geological sections.

Professor Hughes continued to attend the meetings of the Congress up to that at Zurich in 1894.

On the completion of the 25th year of his Professorship, he was entertained by his friends at a public dinner in London, February 26th, 1898, when he was presented with an illuminated address by his students and fellow-workers congratulating him upon the success of the Cambridge School of Geology under his charge.

Professor Hughes married, November 28th, 1882, Mary Caroline, daughter of the Rev. George F. Weston, Honorary Canon of Carlisle

Cathedral. Mrs. Hughes inherits the artistic skill of her father and mother; she is a good linguist and has extensive scientific knowledge, but she devotes herself now entirely to her husband's pursuits. She is a keen geologist, and, in the field on geological excursions, her presence is greatly appreciated.

The writer recalls a delightful excursion some years ago to the Wrekin, led by Professor Lapworth, in which Professor and Mrs. McKenny Hughes took part, and he remembers seeing the three happily engaged hammering at a block of Hollybush sandstone, from which Mrs. Hughes, with her own hammer, extracted some good remains of *Olenellus*, to the joy of the party.

In the far western wilds of America, when their commissariat broke down, Mrs. Hughes cooked for a party of 17, and was described by one of the speakers at the closing meeting as "un vrai rayon de soleil dans nos misères."

In Russia, after announcing Mrs. Hughes' arrival, the Report (Comptes Rendus, p. cclxxxii) adds, "depuis le charme de notre société."

She was the only lady member of the Reichstag at Berlin when old Von Dechen began his Presidential address "Madame et Messieurs."

Mrs. Hughes worked long and diligently at the Pleistocene deposits in the neighbourhood of Cambridge, and published an excellent paper thereon in the GEOLOGICAL MAGAZINE for May, 1888 (pp. 193–207, illustrated by five sections). She also gave a very exhaustive list of the molluscan and other fossil remains found in the gravels and brickearth.

Professor and Mrs. Hughes have a family of three sons: the eldest is a B.A. of Cambridge, and is studying to become an architect; the second son goes up next October; the third is still a schoolboy, but will, if he does not change his mind, take up geology.

Professor Hughes has always been a keen student of archæology (as may be seen from his list of published papers), and has served the office of President of the Cambridge Antiquarian Society. He takes an active part in agricultural organisations, and has for the past two years been President of the Cambridge and Isle of Ely Chamber of Agriculture. A good hall on the ground floor of the new Museum is allotted to Economic Geology, and a collection illustrative of this branch is being formed after the plan of De la Beche's Museum, now unhappily removed from Jermyn Street.

In looking back for half a century of our geological life, and recalling the long line of familiar faces, especially of those who in the days of our novitiate occupied the front rank, one is conscious of the changes which the fleeting years have wrought. Sir Archibald Geikie, addressing his friend Professor Hughes at the Geological Society in 1891, recalled the days of their early friendship, now faded so far into the dim past of life, when, as colleagues on the Geological Survey, they attended together the meetings of the Geological Society in Somerset House, taking seats on a back row,

and gazing down upon the magnates of the science seated beneath. "Little," said he, "did either of us dream that the whirligig of time would eventually place us where we find ourselves to-day."

Sir Archibald Geikie, although retired and no longer the official head of the Survey, occupies the important post of one of the Secretaries to the Royal Society, and is still full of energy and work. Professor T. McKenny Hughes carries on the duties of the Chair of Geology, and maintains active interest in all scientific matters connected with the University, more especially whatever concerns his beloved "Sedgwick Memorial Museum," which is naturally his joy and crown of rejoicing for life, and the outward and visible sign of the high place which geology, palæontology, and petrology hold in Cambridge.

The following is a list of Professor T. McKenny Hughes' published papers and memoirs :—

1866. "Note on the Silurian Rocks of Casterton Low Fell, Kirkby Lonsdale, Westmoreland": Geol. Mag., Vol. III, pp. 206–208 (with a section).
,, "Note on the Junction of the Thanet Sand and the Chalk, and of the Sandgate Beds and Kentish Rag": Quart. Journ. Geol. Soc., vol. xxii, pp. 402–404.
1867. "On the Break between the Upper and Lower Silurian Rocks of the Lake District, as seen between Kirkby Lonsdale and Malham, near Settle": Geol. Mag., Vol. IV, pp. 346–356 (4 sections).
,, "Notes on the Geology of Parts of Yorkshire and Westmoreland": Geol. Polytechnic Soc. W. Riding Yorks (read July 17, 1867).
1868. "On Flint Implements": Soc. Antiq. Lond., vol. iv (March 19), p. 95; Geological and Natural History Repertory, No. 34, p. 126.
,, "On the Two Plains of Hertfordshire and their Gravels": Quart. Journ. Geol. Soc., vol. xxiv, pp. 283–287 (with 2 sections).
1872. "Man in the Crag": Geol. Mag., Vol. IX, pp. 247–250 (with 3 woodcuts in the text).
,, Mem. Geol. Survey: Explanation of Quarter Sheet 98 S.E., illustrating "The Geology of the Neighbourhood of Kirkby Lonsdale and Kendal."
,, Mem. Geol. Survey: Explanation of Quarter Sheet 98 N.E., "The Geology of the Country around Kendal, Sedbergh, Bowness, and Tebay."
,, Mem. Geol. Survey: parts of "The Geology of the London Basin."
1873–4. (Hughes & Rev. D. R. Thomas.) "On the Occurrence of Felstone Implements of the Le Moustier type in Pontnewydd Cave": Journ. Anth. Inst., vol. iii (1874), pp. 387–392.
1874. "Exploration of Cave Ha, near Giggleswick, Settle, Yorkshire": Journ. Anth. Inst., vol. iii, pp. 383–387.
1876. "Notes on the Classification of the Sedimentary Rocks": Rep. Brit. Assoc. for 1875, Trans. Sects., pp. 70–73.
,, "Geological Measures of Time": Roy. Inst. Gt. Brit., Lecture, March 24 (Proc., vol. viii, pp. 129–136).
,, "On a Series of Specimens illustrating the Formation, Weathering, and Fracture of Flint," with note by Professor Stuart; Proc. Camb. Phil. Soc., vol. iii, pt. 1, p. 12.
,, "On the Evidence for Preglacial Man": Proc. Camb. Phil. Soc., vol. iii, pt. 1, pp. 16, 17.
1877. "Antiquity of Man: the Evidence afforded by the Gravels and Brickearth": Journ. Anth. Inst. (November).
,, "On the Silurian Grits of Corwen, North Wales": Quart. Journ. Geol. Soc., vol. xxxiii, pp. 207–212 (with 2 sections).
1878. "On the Pre-Cambrian Rocks of Bangor": Quart. Journ. Geol. Soc., vol. xxxiv, pp. 137–146 (with a section).
,, "On the Base of the Silurian System": Proc. Camb. Phil. Soc., vol. iii, p. 67.

1878. "On the Base of the Cambrian Rocks in North Wales": Proc. Camb. Phil. Soc., vol. iii, p. 89.

,, "On the Relation of the Appearance and Duration of the various Forms of Life upon the Earth to the Breaks in the Continuity of the Sedimentary Strata": Proc. Camb. Phil. Soc., vol. iii, pt. 6, pp. 247–258.

1879. "Further observations on the Pre-Cambrian Rocks of Caernarvon": Quart. Journ. Geol. Soc., vol. xxxv, pp. 682–693 (10 sections in text and folding plate xxxvi).

,, "On the Silurian Rocks of the Valley of the Clwyd": Quart. Journ. Geol. Soc., vol. xxxv, pp. 694–698 (2 page sections).

1880. "The Present State of the Evidence bearing upon the question of the Antiquity of Man": Journ. Trans. Vict. Inst., vol. xiii, pp. 316–327.

,, "On the Transport of fine Mud and Vegetable Matter by Conferva": Proc. Camb. Phil. Soc., vol. iii, pp. 339–341.

,, "On the Geology of Anglesey" (No. 1): Quart. Journ. Geol. Soc., vol. xxxvi, pp. 237–240.

,, "On the Altered Rocks of Anglesea": Proc. Camb. Phil. Soc., vol. iii, pt. 8, pp. 341–348.

,, "On the Cae Seynan Boulder": Ninth Rep. Brit. Assoc. Committee on Erratic Blocks (1882); Proc. Camb. Phil. Soc., vol. iii (1880), p. 89.

1881. "On the evidence of the later movements of Elevation and Depression in the British Isles": Journ. Trans. Vict. Inst., vol. xiv, pp. 248–262.

,, "Notes on Italy, and what she is doing for Science": Chester Soc. Nat. Sci.; Chester Guardian, Nov. 5.

,, "On the Basement Beds of the Cambrian of Anglesey": Geol. Mag., Dec. II, Vol. VIII, pp. 333–334.

1882. Professor Hughes communicated (Nov. 16) to the Geological Society a statement of the results of the International Geological Congress at Bologna: Proc. Geol. Soc., pp. 2–4; Quart. Journ. Geol. Soc., vol. xxxviii.

,, "On the Geology of Anglesey" (No. 2): Quart. Journ. Geol. Soc., vol. xxxviii, pp. 16–28 (with 4 sections in text).

,, "On the Lower Cambrian of Anglesea": Rep. Brit. Assoc. for 1881, pp. 643, 644.

,, "On the Gnarled Series of Amlwch and Holyhead in Anglesea": Rep. Brit. Assoc., p. 644.

1883. "Excursion of the Geologists' Association to Bangor, Snowdon, Holyhead, etc.": Proc. Geol. Assoc., vol. viii, No. 4, pp. 195–207.

,, Biographical Notice of Adam Sedgwick: Proc. Yorks. Geol. Polytechnic Soc. (November).

,, "On the Brecciated Bed in the Dimetian at St. Davids": Geol. Mag., Dec. II, Vol. X, pp. 306–309 (with a woodcut).

,, "On some Fossils supposed to have been found in the Pleistocene Gravels of Barnwell, near Cambridge": Geol. Mag., Dec. II, Vol. X, pp. 454–456 (and list of Mollusca).

1884. The International Geological Congress at Berlin (postponed): Geol. Mag., Dec. III, Vol. I, p. 432.

,, "On the so-called *Spongia paradoxica*, S. Woodw. (1830), from the Red and White Chalk of Hunstanton": Quart. Journ. Geol. Soc., vol. xl, pp. 273–279.

,, "On some Tracks of Terrestrial and Freshwater Animals": Quart. Journ. Geol. Soc., vol. xl, pp. 178–186 (plates viii–xi).

,, "On the supposed Roman Camp at Whitley, near Alston, and on the Maiden Way as a Roman Road": Proc. Camb. Antiq. Soc., vol. vi (Nov. 10), p. 41.

1885. "Notes on the Geology of the Vale of Clwyd": Proc. Chester Soc. Nat. Sci., No. 3 (8 plates); Geol. Mag., Dec. III, Vol. III (1886), p. 89.

1886. "On some Perched Blocks and Associated Phenomena": Quart. Journ. Geol. Soc., vol. xlii, pp. 527–539 (with 5 illustrations in the text).

,, "On the Ffynon Beuno Caves": Geol. Mag., Dec. III, Vol. III, pp. 489–492.

,, "On the Silurian Rocks of North Wales": Rep. Brit. Assoc. Birmingham, Sect. C (Geology); Geol. Mag., Dec. III, Vol. III, p. 509.

,, "Notes on some Sections in the Arenig Series of North Wales and the Lake District": op. cit.; Geol. Mag., op. cit., p. 509.

1886. "On the Pleistocene Deposits of the Vale of Clwyd": op. cit.; GEOL. MAG., op. cit., pp. 509–510.

,, "Caves and Cave Deposits": Proc. Chester Soc. Nat. Sci. and Lit., pt. iv (1893), p. 161.

1887. "On Caves": Journ. Trans. Viet. Inst. (Feb. 21).

,, "On the Ancient Earthworks between the Mouth of the Tyne and the Solway": Proc. Camb. Antiq. Soc., vol. vi, p. 355; vol. ix (1895), p. 172.

,, "On the Drifts of the Vale of Clwyd and their relation to the Caves and Cave-Deposits": Quart. Journ. Geol. Soc., vol. xliii, pp. 73–120 (double plate ix and 4 figures in text).

,, "On the Ancient Beach and Boulders near Braunton and Croyde, in North Devon": Quart. Journ. Geol. Soc., vol. xliii, pp. 657–670 (with 6 text-figures).

,, "On some Brecciated Rock in the Archæan of Malvern": GEOL. MAG., Dec. III, Vol. IV, pp. 500–503 (with a woodcut).

,, "Bursting Rock-Surfaces": GEOL. MAG., loc. cit., pp. 511–512 (with a figure in text).

1888. "On the Position of the Obermittweida Conglomerate": Quart. Journ. Geol. Soc., vol. xliv, pp. 20–24 (with a section in text).

,, "On the Cae Gwyn Cave": Quart. Journ. Geol. Soc., vol. xliv, pp. 112–137 (with 8 text-illustrations).

1889. "Note on the Lower Cambrian of Bethesda, North Wales": GEOL. MAG., Dec. III, Vol. VI, pp. 8–15 (with 4 text-figures); also p. 96.

,, "On some Antiquities found near Hauxton, Cambridgeshire": Proc. Camb. Antiq. Soc., vol. vii (May 13), p. 24.

,, "On Cuts on Bone as evidence of Man's Existence in Remote Ages": Journ. Trans. Viet. Inst. (May 6).

,, "On the Manner of Occurrence of Beckite, and its bearing upon the Origin of Siliceous Beds of Palæozoic Age": Min. Mag., vol. viii, No. 40, p. 265.

1890. "The Life and Letters of the Reverend Adam Sedgwick." 2 vols. By J. W. Clark & T. McK. Hughes. 8vo. Cambridge.

1892. "On the Recent Discovery of two Ancient Ditches and Objects of Mediæval Date between Hobson Street and Sidney Street, Cambridge": Proc. Camb. Antiq. Soc., vol. viii, p. 32.

1893. "On some Ancient Ditches and Mediæval Remains found in the course of Recent Excavations near the Pitt Press": Proc. Camb. Antiq. Soc., vol. viii (Oct. 23), p. 255.

,, "On Offa's Dyke": Archæologia, vol. liii; Proc. Camb. Antiq. Soc., vol. vii, p. 200.

,, "On the Castle Hill, Cambridge": Proc. Camb. Antiq. Soc., vol. viii, p. 173.

,, "Criticism of the Geological Evidence for the Recurrence of Ice Ages": Pt. i, 'Condition of the Surface of the Boulders and of the Solid Rock' (p. 98); Pt. ii, 'The Mode of Transport of the Boulders and other Drift' (p. 219); Pt. iii, 'The Evidence as to the Extent of Earth Movements, and their Relation to Glacial Phenomena' (p. 224); Pt. iv, 'Summing-up.'

1895. "On the Camp at Ardoch in Perthshire": Proc. Camb. Antiq. Soc., vol. viii; Archæologia, vol. liv, pp. 267–372.

1896. "On the more important breeds of Cattle which have been recognized in the British Isles in successive periods, and their relation to other archæological and historical discoveries": Archæologia, vol. lv, pp. 125–158.

,, Opening Address to the Antiquarian Section of the Archæological Institute at Canterbury, with discussion of 'Eoliths,' etc.: Arch. Journ., vol. liii (September), p. 249.

,, "On some Chipped Flints from the Plateau-Gravel of Salisbury and elsewhere": Proc. Camb. Phil. Soc., vol. ix, p. 120.

1897. "On the evidence bearing upon the early history of man which is derived from the form, conditions of surface, and mode of occurrence of dressed flints": Arch. Journ. (December), vol. liv.

,, "The Landing-place of St. Augustine," being Dissertation III in "The Mission of St. Augustine to England, according to the original documents," being a handbook for the thirteenth centenary. Edited by Arthur James Mason, D.D.

1897. "On some Waxed Tablets said to have been found at Cambridge": Archæologia, vol. lv, pp. 257–288; Proc. Camb. Antiq. Soc., vol. viii, p. 41.
,, "Further Observations on the Ditches round Ancient Cambridge, with special reference to the adjoining ground": Proc. Camb. Antiq. Soc., vol. ix (Feb. 1), p. 370.
1898. "The Race represented in the Archaic Statues of Athens": Cambridge Review (April 28).
1899. "On Nationality": Journ. Trans. Vict. Inst. (May 1).
,, "On the Archæology and the Geography of the Fenland": Journ. Brit. Arch. Assoc. (December).
1901. "Marathon": The Classical Review, vol. xv, No. 130; translated into Modern Greek in Panathenaia (Nov. 30), p. 114.
,, "Amber": Arch. Journ., vol. lviii, No. 229, p. 35.
,, "Soils, and Matters relating thereto": Journ. Camb. and Isle of Ely Chamber of Agriculture (Feb. 9).
,, "On the Natural Forms which have suggested some of the commonest Implements of Stone, Bone, and Wood."
1901–2. "Ingleborough." Pt. i: Proc. Yorks. Geol. Polyt. Soc., vol. xiv, p. 125: Pt. ii, ib., p. 323.
1902. "On Ancient Horse-shoes": Proc. Camb. Antiq. Soc., vol. x, p. 249.
,, "On the Remains of the Dog, Prehistoric, Roman, and Mediæval, found near Cambridge": Proc. Camb. Antiq. Soc., vol. x, p. 254.
,, "The Early Potters' Art in Britain": Arch. Journ., vol. lix, No. 235, pp. 219–237.
,, "On some indications of a Roman Potter's Field near Jesus College, Cambridge": Proc. Camb. Antiq. Soc., vol. x, p. 194.
,, "On the Potter's Field at Horningsea, with a Comparative Notice of the Kilns and Furnaces found in the Neighbourhood": Proc. Camb. Antiq. Soc., vol. x, p. 174.
1903. "On some Buried Buildings, with special reference to Herculaneum": Arch. Journ., vol. lx, p. 256.
1904. "The War Ditches near Cherryhinton, Cambridge."
1905. "Arboriculture on large and small Agricultural Holdings": Journ. Camb. and Isle of Ely Chamber of Agriculture (Jan. 14).

Professor Hughes has been a frequent contributor to *Nature* and other scientific periodicals.

II.—Further Notes on the Stratigraphy and Fauna of the Trimmingham Chalk.

By R. M. Brydone, F.G.S.

(PLATES II AND III.)

THIS paper is primarily a record of observations made at Trimmingham since those recorded in a pamphlet entitled "The Stratigraphy and Fauna of the Trimmingham Chalk."[1] But as the Polyzoa of the Trimmingham Chalk comprise a remarkably large number of species which appear to be at present undescribed and are very characteristic of this horizon, I have taken this opportunity of describing some of the most prominent of these forms, partly in the hope of directing the attention of other collectors to their range and partly to facilitate the classification of the very large quantity of material I have accumulated. I have also taken this opportunity of giving a list of species from the Chalk between Cromer and Weybourne.

[1] London: printed separately, Dulau & Co., 1900.

In the recently published memoir of the Geological Survey on the Upper Chalk of England Mr. Jukes-Browne has established a zone of *Ostrea lunata* for the Trimmingham Chalk. It is clearly desirable that a formal zone should be so created now that the fauna is known to be so distinctive, in spite of the present impossibility of identifying its upper or lower boundary, but the choice of *O. lunata* as a zone-fossil, though natural, is unfortunate. *O. lunata* has two characteristics of an ideal zone-fossil in that it is, as far as we know, almost confined to the Trimmingham Chalk, and that in that Chalk zone it always occurs abundantly, if at all. But it fails to fulfil the most important requirement for a good zone-fossil in that it is not distributed all through its so-called zone. There are at least ten, and probably more, distinct horizons occurring in four sequences at different points. The relations of the members of each sequence to one another are quite clear; the relations of the sequences to one another are at present doubtful (except that 3 is clearly identical with part of 4), but I believe that series 1 is the uppermost and series 4 the lowest, and I often fancy that series 2 is composed of the bottom bed of series 1 and the upper beds of series 3. The series (in descending order in each case) is as follows:—

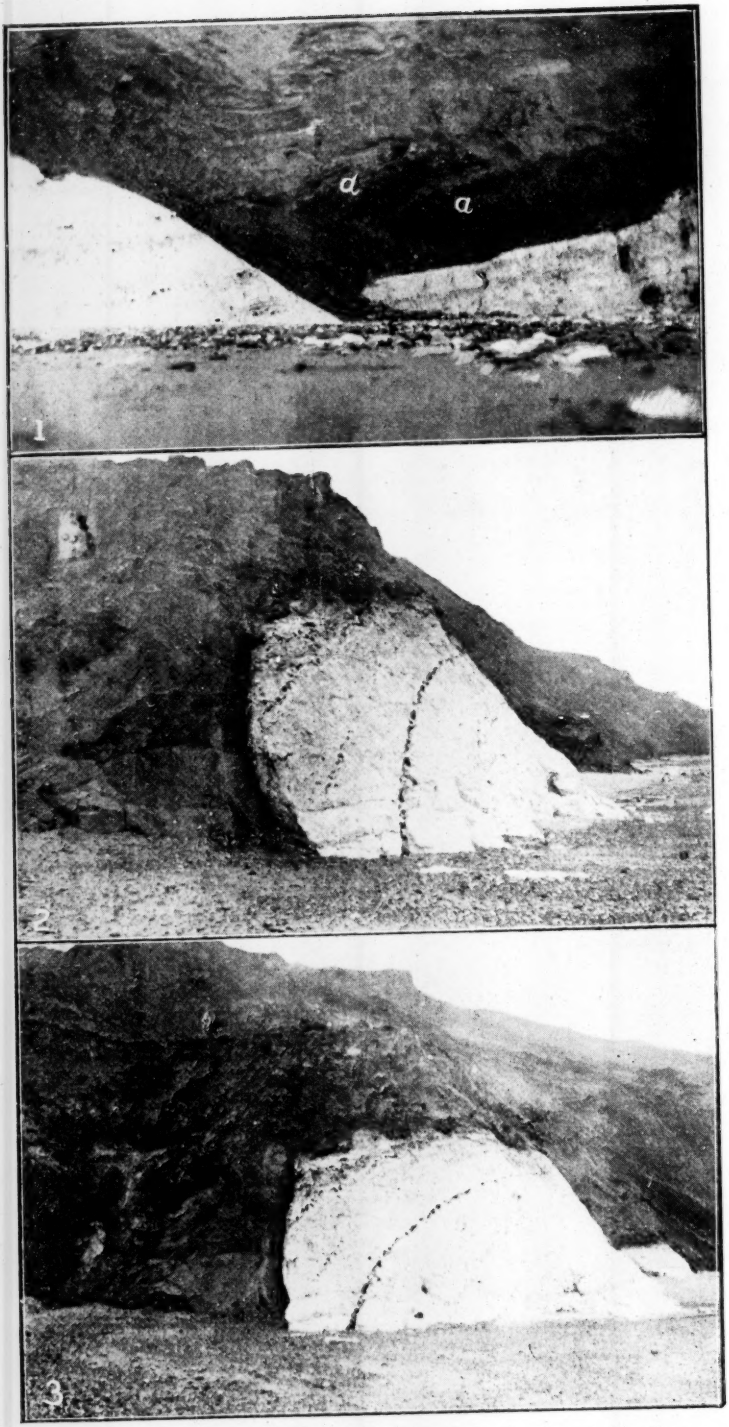
1. Grey chalk with abundance of small *Ostrea vesicularis*.
   White chalk with *O. lunata*.
   ,, without *O. lunata*.
   ,, with *O. lunata*.
   ,, without *O. lunata*.
   Grey chalk with *O. canaliculata*, *O. inæquicostata*, *Terebratula obesa*, and *Stegaster*.
2. Grey chalk with *O. canaliculata*, *O. inæquicostata*, *T. obesa*, and a grit seam or bed at base.
   White chalk with *O. lunata*.
   ,, without *O. lunata*.
3. White chalk with *O. lunata*.
   ,, without *O. lunata*.
   Hard chalk, weathering very lumpy.
4. White chalk with *O. lunata*.
   ,, without *O. lunata*.
   Hard chalk, weathering very lumpy.
   White chalk very much mottled by grey blue streaks. (It has only just been disclosed below the hard chalk, and I cannot yet say anything of its fauna except that it does not contain *O. lunata*.)

Now a remarkable thing about *O. lunata* is that it occurs *exclusively* (with the exception of one specimen) at the horizons noted as characterised by it. It will be seen that there are, at most, five of these, and at least nine without *O. lunata*. It is true that the horizons with *O. lunata* are all of some thickness, and owing to the vast profusion of beautiful specimens of this very striking form which they contain, and to their supplying the greater part of the two bluffs—the only chalk always accessible—they figure very prominently in one's impressions of the Trimmingham Chalk as a whole. But it is safe to say that in more than half of the total thickness of Chalk exposed *O. lunata* is not to be found, and

this without reckoning in the thickness of the anomalous northern part of the south bluff, which may fairly be quoted as not containing *O. lunata*, as only one specimen has been found in it, and that very dwarfed. But there are fossils which do occur throughout the Trimmingham Chalk, yet, as far as I know, are confined to it, such as *Terebratulina gracilis*, *T. Gisei*, *Pentacrinus Agassizi*, and *P. Bronni*, to take well-marked and fairly plentiful forms. There could be no hesitation in selecting as the zone-fossil *Terebratulina gracilis* if it were not for the unfortunate but universal misapplication of this specific name to the characteristic fossil of the upper zone of the Middle Chalk. *T. Gisei*, considered by itself as a possible zone-fossil, is too small to be found with certainty, even if abundant, and it is hardly that. But *T. gracilis* is such an ideal zone-fossil that I propose to remove the objection to it stated above by naming the Trimmingham Chalk "zone of *Terebratulina gracilis* and *T. Gisei*," or, for familiar use, "zone of *Terebratulina*," it being understood that *T. Gisei* is not conclusive when occurring by itself, but that *T. gracilis* is. *Pentacrinus Agassizi* and *P. Bronni* could, of course, be used to characterise a "zone of *Pentacrinus*," but that would create great difficulty with the chalk of the erratics between Overstrand and Sidestrand, a part of the cliff which is unfortunately being ruined for geological observation by sloping and path-making operations. Before the era of sloping set in these erratics were about ten in number, and all (with one exception) lay on a thick bed of boulder-clay, which ran with great regularity at a practically unvarying height above the beach from the Overstrand breakwater to the grounds of the new hotel at Sidestrand. My attention was first drawn to these erratics by Miss Mary Townsend, of Oatlands Park, Weybridge, who happened to be staying at Overstrand in 1896, at a time when a storm had swept away the sand on the beach and exposed a great number of chalk boulders, no doubt all that had fallen from above for some years. I had then just become keenly interested in the Chalk of the Norfolk coast, and she, being aware of this, picked out for me all the fossils she could with a penknife, including a perfect *Micraster cor-anguinum* of the typical Norwich shape, a very creditable performance for a lady with no previous experience of fossils and armed only with a penknife. I have on several occasions been able to add to this collection, the salient points of which are the presence of *Rhynchonella Reedensis*, which occurs freely in the Cromer Chalk but not at all at Trimmingham, and the abundance of a *Pentacrinus* which is neither *Agassizi* nor *Bronni*, and does not occur either at Trimmingham or in the Cromer Chalk. The occurrence of a *Pentacrinus* is a strong link to the Trimmingham Chalk with its abundance of *Pentacrinus*, and this association is strengthened by the character of the chalk itself, which is often white, much mottled with blue-grey patches, just like so much of the white chalk at Trimmingham, and it is tempting to group this chalk with the Trimmingham Chalk rather than with the Cromer Chalk. At the same time the presence of *R. Reedensis* indicates that it is definitely older than the Trimmingham

Chalk, and this is just what one would expect if, as is probable from their unaltered condition, these boulders are of quite local origin.

The exception above mentioned was a large boulder, quite 30 feet high, immediately under the new hotel at Sidestrand. Unfortunately this was overlaid by a soft bed full of water, which kept its surface constantly obscured by a downwash of mud, and it was impossible to collect from it. It has now been destroyed in the sloping of the cliffs, or, if anything be left of it, it is turfed over and concealed for good. I did get from the foreman of the works a promise to let me know when they began to cut into the boulder, but the promise was not kept, and the operation was carried out in my absence, and a valuable opportunity thereby lost. One thing about it, however, was not entirely obscured by the mud, and that was the presence at about 4 feet from the base of a bed of laminated marl some 2 inches thick. This remarkable occurrence may mark the boundary between the zone of *Terebratulinæ* and the Cromer Chalk (which is decidedly identical in age with that now exposed near Norwich, and therefore belongs to the zone of *B. mucronata*). Some well-marked line of demarcation seems not unlikely, as there is a considerable palæontological break. Not only *Rh. Reedensis* but also *Terebratula sexradiata* are not uncommon in the Cromer Chalk, but still unknown at Trimmingham, and *Micraster cor-anguinum*, which is abundant (relatively speaking) in the Cromer Chalk, is so scarce at Trimmingham that I have not yet found a fragment of *Micraster* there, though Mr. Savin has two specimens, apparently from the hard basement bed. There are also four very characteristic Upper Senonian Polyzoa, which in the South of England are found in the uppermost beds (with abundant specimens of *Magas pumilus*) of the *B. mucronata* zone, but which are not found at Trimmingham, though the environment there must have been so very favourable to Polyzoa that they might be fairly expected to occur there if they still persisted in the English seas. I have described and figured three of these, which I cannot identify with published figures. It so happens that I have not yet recognised any of these three in the *B. mucronata* chalk of Norfolk, but the fourth, *Membranipora* (? *Homalostega*) *clathrata*, is abundant in the Cromer Chalk, and adds increased significance to the disappearance of *Rh. Reedensis* and *Terebratula sexradiata*. Under these circumstances I should be very chary at present of adopting a zonal description of the Trimmingham Chalk which would allow of the Sidestrand erratics containing *Rh. Reedensis* being included with it. Of course, if the great erratic was representative of the cliff from which the other erratics were derived, it would be quite conceivable that the marl band should be the boundary of the two zones, and the mixture of *Pentacrinus* and *Rh. Reedensis* in the fossils obtained be due to the presence of boulders both from above and below the boundary. (Many puzzling records are probably due to an assemblage of fossils gathered from a section containing the boundary of two zones being regarded as a naturally contemporaneous series, and assigned to the more prominent of the two zones.)



Views of the Trimmingham Chalk Bluffs, Norfolk Coast.

Should it ever be ascertained that there *is* a point at which the forms above mentioned all disappear, that point may safely be taken as the upper limit of the *B. mucronata* zone of Norfolk. [I do not say 'Norwich Chalk,' because I have a very strong opinion that that term is wholly unscientific. If it implies, as presumably it does, that all the chalk which has ever been exposed within two or three miles of Norwich is of the same zone, that zone must be the zone of *B. mucronata*, and the term 'Norwich Chalk' is a mere synonym. It is undoubtedly the fact that the sections now accessible (Trowse, Thorpe, and Whitlingham) are all in chalk which contains *B. mucronata* freely, and cannot on any pretext be assigned to any other zone. But many of the fossils recorded from the 'Norwich Chalk,' e.g. the Cephalopoda, seem decidedly unlikely to occur in such chalk as that now exposed, and probably the chalk in which *Baculites* was abundant was very different stuff from that now to be seen. In that case the 'Norwich Chalk' is a 'hotchpotch' of an unknown number of zones which should, with its so-called fauna, be discarded as soon as possible in all attempts at zonal classification. I have really very little doubt as to the danger involved in treating the Norwich Chalk as a zonal unit, and many of the peculiar species would probably find a place as synonyms if Samuel Woodward's types could be found. Some can be so treated from the plates; e.g., *Serpula accumulata* is almost certainly a synonym of *S. vortex*, *S. pentangulata* of *S. canteriata*, *S. carinata* of *S. fluctuata*, *S. contracta* of *S. gordialis* (if Professor Deecke rightly identified the specimens to which he assigned the latter name, which has not been very freely admitted by other collectors), and *Plagiostoma granulosum* of *Lima granulata*. At any rate, we are not warranted by any accessible information in taking it for granted that the recorded fauna of the 'Norwich Chalk' has been derived from pits exclusively in the same zone. Most of the pits named are now inaccessible and cannot be re-examined.] Unfortunately, in discussing the limits of the zones of the Upper Chalk in Norfolk we get very little assistance from the nearest area in which those zones occur again at all freely, i.e. in Sussex and Hants. The zone of *B. quadrata* south of the Thames is often very fossiliferous, and the zone of *B. mucronata* is often even more so, both zones being conspicuous for abundance of free-growing Polyzoa. But in Norfolk, and indeed generally on the north of the Thames, both these zones are much less fossiliferous and practically devoid of free-growing Polyzoa. In fact, they present quite a different aspect; they are much more uniform and much finer apparently in texture. It may be only due to increased depth, but I have always felt tempted to postulate the existence in the Cretaceous sea of a submerged ridge separating the two areas or basins. The connection of the Norfolk area with the Rügen sea, which is so marked in the Trimmingham Polyzoa, must have existed at least as early as the age of the chalk round Norwich and near Cromer, in which *Homalostega pavonia*, described from Rügen in 1839 but not recorded from any other locality except Trimmingham, is quite abundant. Though Polyzoa are abundant at the top of the

B. mucronata chalk of Hampshire, I have not yet found any Rügen forms there, and this may well be more than a mere coincidence.

Stratigraphy.

In this department I have to acknowledge my indebtedness to Mr. G. P. Bidder, who was staying at Mundesley during late September and October of 1905, a time of very rough weather and great variety of exposures. Though not a geologist, he took great interest in the local geology and gave me much assistance in many ways. Amongst other things he pointed out to me that in my previous pamphlet I had overlooked the fact that the magnetic north is about 20° west of true north, and that I ought to mention that all my bearings were magnetic. I have, for convenience, continued to use magnetic bearings in this paper.

South Bluff.

Very little further development has taken place here, but the accuracy of the partly hypothetical presentation of the low southern prolongation in fig. 2 of my previous pamphlet has been established by fuller exposures both as to the continuity of the flint lines and their identification with those to the right of A B. It also turned out that at the furthest point to which they are shown extending they bend sharply down, and all but the highest of the lines shown to the right of A B come in on the slope. The highest of these was found to be dipping at quite 75° almost due south. (This very high dip on the south side of a ridge is by no means uncommon elsewhere in this area.)

A great number of cavities have recently appeared in the upper beds of the southern part of the bluff, and it *appears* as if these cavities expand as they penetrate the bluff. This is just what would be expected if they were cavities formed in a cliff facing to the south or south-west, and tends to confirm the view that this part of the bluff, at any rate, is the remains of a headland which faced a sea lying to the south or south-west.

A good deal of the sand in the gap between the two parts of the bluff has been cleared away and the south-easterly face of the northern part exposed to a point directly behind and on the same level as the northern end of the southern part and only 8 yards away from it (Plate II, Fig. 1). The marked difference in the physical characters of the two parts remains unaffected, and the conclusion that they are separated by a fault seems now inevitable *if* the north part is not an erratic, as to which no further evidence has been obtained. I have found a single specimen of *O. lunata* in the northern part.

North Bluff.

Here there have been some most interesting developments owing to the rapid erosion which has taken place, and is still proceeding. A great deal of erosion took place in the Winter of 1900–1 all round the bluff, and I was fortunate enough to obtain through Mr. Savin, of Cromer, the assistance of a local amateur photographer,

who took in February, 1901, the photographs reproduced as Plate II, Figs. 2 and 3, and Plate III, Figs. 4 and 5. Fig. 2 shows the bluff as seen from a point on a line drawn through the bluff parallel with the beach-line. It will be noticed that one of the lines of flints appears to be vertical. That this is an illusion can be seen from Fig. 3, which was taken from a point approximately on the strike of the same line of flints, which (as I stated in my previous pamphlet, and have several times since checked) is *not* parallel to the beach-line. The appearance of verticality is due to the surface presented being oblique both to the line of vision and to the horizontal plane.

Fig. 4. Plate III, shows a very interesting development on the north side of the bluff. A deep bay had been hollowed out with a long south side and very short north side. The south side was formed by first the bluff itself and then chalky clay, as shown in fig. 1 of my previous pamphlet. But the clay now proved to be only a narrow triangular mass, succeeded by a sloping bank of chalk which formed the rest of that side of the bay. The head of the bay was formed of talus from the cliffs above, and apparently concealing the connection of the sloping bank of chalk with the chalk which emerged again to form the short north side. This north side ended in a clean-cut cross section, which showed it to consist of a layer of chalk from two to three feet thick resting on chalky clay with an apparent bedding parallel to the base of the chalk, the junction plane dipping seawards at an angle of about 55°. The whole of the chalk exposed behind the triangular mass of clay was grey, and exhibited many peculiarities which will be dealt with fully later on.

Fig. 5, Plate III, gives a close view of the pinnacle of clay and its immediate surroundings, and there are a number of points of interest about it. One is the distance from which the clay runs in under the chalk on either side. Shortly before the photograph was taken the sand was still further cleared away and the clay extended quite two feet further under the bluff. In this connection it is to be observed that a junction between the chalk and the clay has been seen on the foreshore close by for a distance of some 30 yards, throughout the whole of which the clay is running in under the chalk for a distance of at least nine inches, and may, for all appearances, underlie it altogether. There are many other points on the foreshore where the junction of chalk and clay has been observed, and in all the plane of junction is either vertical or else almost horizontal with the clay running under the chalk. Again, in the case of a fault on the foreshore almost opposite the north bluff, the chalk on either side of the fault has at one point been broken away so as to form a long narrow steep-sided pool about 18 inches deep. The bottom of this pool is formed by what appears to be the truncated top of a dome of clay, composed of fairly regular concentric layers of clay of varying colours, suggesting very strongly that the clay has been forced up from beneath into a cavity or crack. The point at which this occurs is at least 30 yards from the nearest exposure of clay.

Another point is the pseudo-stratification of the clay roughly parallel to the sides of the fissure. This point is not well brought out by the photograph, in which it only appears by the light-coloured band. It was, however, much more apparent to the eye, being more or less marked all through the mass owing to slight variations in colour of the different bands, a reproduction of which is hardly to be expected by photography. Here again we have appearances strongly suggesting that a pseudo-stratified mass of clay has been forced upwards into a cavity.

Another point which is not clearly shown by the photographs, is that the face presented by Fig. 4 was an almost plane surface apparently representing a clean section through the bluff, the clay and a homogeneous mass of grey chalk at the back.

A fourth point which cannot, owing to the shadow, be distinguished at all in the photographs, is that there was a slender arch of chalk not more than two feet thick extending over the clay pinnacle and connecting the bluff with the chalk behind. I was only just able to reach the arch and ascertain that *Ostrea lunata* occurred in it. The seaward face of the bluff was at this time too steep to climb with any comfort, and the highest chalk which could be reached from the beach was normal *O. lunata* chalk, which apparently continued up to the point where the nature of the chalk was completely obscured by dirt.

Since the Spring of 1901 there has been steady denudation at this point. Unfortunately I was not able to obtain any photographic record until the Autumn of 1904, but the course of denudation in the meanwhile may be summarized as follows :—

1. *The Original Bluff.*

The top of the bluff remained inaccessible and obscured by sand for some time. It became gradually cleaner and more accessible, but during 1901 I found nothing but *O. lunata* chalk exposed. By 1902 the downwash of mud had practically ceased and the face of the bluff had been considerably stepped, and it was gradually revealed that the bluff was capped by a bed of grey chalk of a fairly uniform thickness of two feet and with a perfectly clean-cut boundary between it and the *O. lunata* chalk. (As this grey chalk will be referred to again later on, I take this opportunity of saying that its appearance is sometimes only to be detected by the change in colour. But, as a rule, it is separated from the *O. lunata* chalk which is invariably found beneath it by an exceedingly thin seam of fine grit, containing scattered flint pebbles of various sizes up to that of a good-sized potato. In places this seam swells out into a definite bed as much as two inches thick containing small rolled pieces of chalk. The presence of rolled flints has not to my knowledge been before recorded in the English or, indeed, any Chalk. It throws an important light on the time of consolidation of the flints, which must have taken place in this case almost simultaneously with the deposition of the Chalk in which they were formed.) The grey chalk was plainly unconformable to the *O. lunata* chalk below,

for the three upper lines of flint shown in fig. 1 of my previous pamphlet ran steadily and strongly up to the grit seam at the base of the grey chalk, and were then cut off by it. A fairly accurate representation of this state of things can be got by adding to the last-mentioned figure two feet of chalk resting horizontally on the truncated ends of the lines of flint. As the bluff was cut back these lines of flint sank, and after a time the lowest came wholly below the base of the grey chalk and formed a perfect arch.

2. *The Fissure and its immediate surroundings.*

The triangular mass of clay filling the fissure was denuded much more rapidly than the chalk, and soon there was produced a definite inlet between two faces of chalk, which gave partial cross-sections of the masses of chalk. It became almost at once apparent that the grey chalk was really only a thin coating (thicker at the top and bottom on the slope than in the middle, but nowhere more than 18 inches thick) of a sloping surface of *O. lunata* chalk. The filling of the gap by clay proved in places to be incomplete, so that a considerable space was left between the top of the clay and the chalk arch, indicating that the clay was either very slightly fluid or not under great pressure when forced in. The latter cause seems the more probable, as if there *had* been great pressure at this point it is hardly possible that an arch of chalk, with a maximum thickness of two feet, should have remained unbroken. The grey chalk soon appeared in the arch forming the upper part of it in a gradually increasing proportion and connecting the grey chalk on the bluff with that on the 'slope,' but it never completely cut out the *O. lunata* chalk which still formed the lower six inches or so when it was destroyed by the waves. About two-thirds of the way up the slope, was one of the points where the grit seam swelled out into a regular bed with pebbles and rolled chalk.

3. *The Bay of Grey Chalk.*

The first event was the removal of the talus at the head of the bay and the exposure of a continuous surface of grey chalk beneath it. Then the grey chalk became thinner and finally disappeared altogether, both at the head of the bay and along the median (horizontal) line of the 'slope.' But while in the latter case the underlying stratum was *O. lunata* chalk, as might be expected, in the former case it proved to be clay similar to that at the back of the bluff. Further denudation of the grey clay exposed at a number of points *O. lunata* chalk coming in between the grey chalk and the clay as the edge of the grey chalk shrank back from the cliff (Pl. IV, Fig. 9).

4. *The Bay on the South of the Bluff.*

This is but poorly shown in our Pl. II, Fig. 2, which was taken at a time when there was no particular feature of interest in the south bay. It only offered a section through the bluff and a mass

of clay immediately behind it, and behind and above both a tumbled mass of glacial beds, separated from the chalk by a thin layer of dark laminated clay.

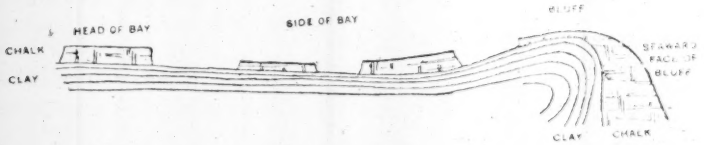


Diagram of Chalk Bluff, showing the mass of clay immediately behind it and the discontinuous line of chalk masses round the Bay.

Towards the end of 1903 the grey bed which had been exposed at the top of the bluff began to throw out a 'stringer' (or broken horizontal line of grey chalk) over the mass of clay behind it, and early in 1904 there was a discontinuous line of chalk masses visible for a considerable way round the bay. They were apparently supported by a mass of clay, which was turned under itself against the bluff, judging from the banding of the clay as sketched very roughly in the above diagram.

EXPLANATION OF PLATES.

Views of Trimmingham Chalk Bluffs, Norfolk Coast.

PLATE II.

FIG. 1.—South Bluff; gap between northern and southern part. *a*, *a*, masses of coarse shingle.

FIGS. 2 and 3.—Two views of North Bluff as seen from the south (1901).

PLATE III.

FIG. 4.—North Bluff; view of north bay (January, 1901).

,, 5.—Pinnacle of clay separating the North Bluff from the chalk at the back of it (January, 1901). The connecting roof of chalk is in deep shadow, and therefore very indistinct.

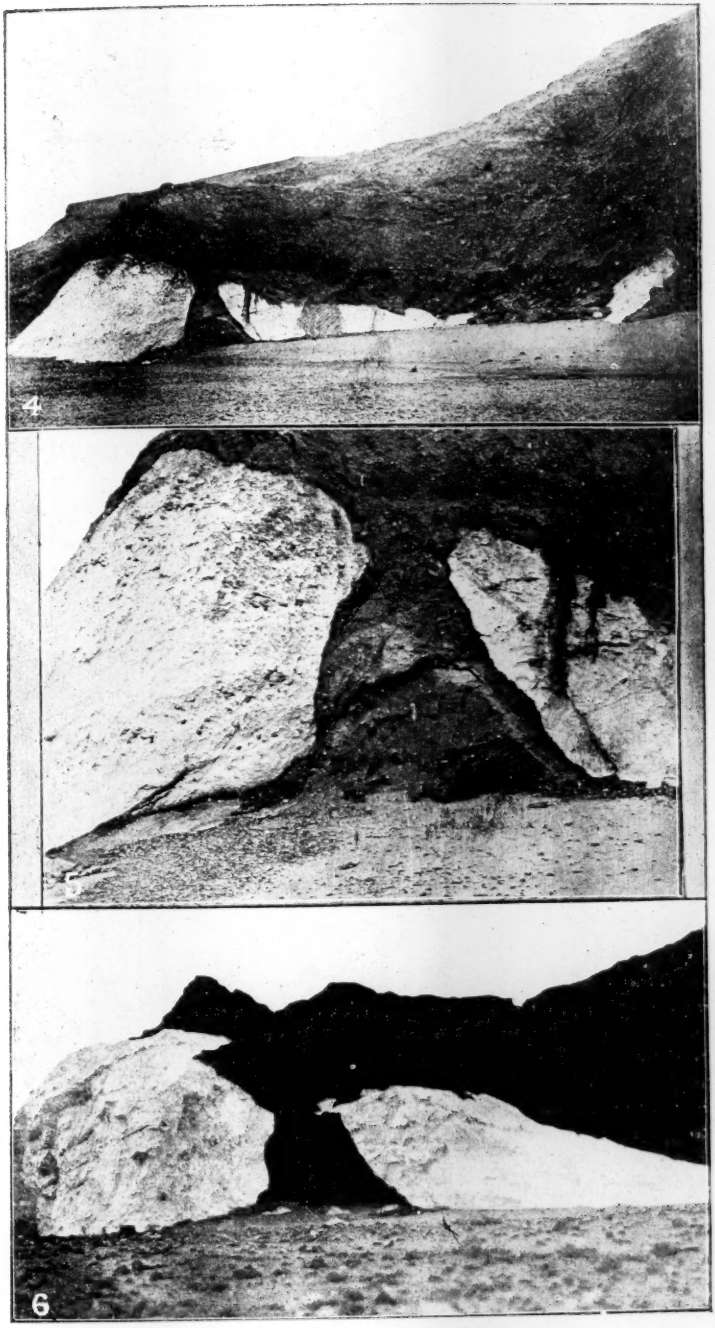
,, 6.—View of the North Bluff and the exposure of chalk in the bay (November, 1904).

(To be continued.)

III.—On the Raised Beaches of the Geological Survey of Scotland.

By T. F. Jamieson, F.G.S.

IN the maps and memoirs of the Geological Survey of Scotland there is frequent mention of raised beaches at 50 and 100 feet above the present sea-level. Mr. James Geikie, too, in his well-known book on the Great Ice Age, confidently assumes the existence of beaches at these two levels. It is therefore with some degree of reluctance that in the following remarks I venture to question the reality of these supposed beaches; but it will lessen the field of controversy if I confine my observations to the east side of Scotland. Matters may probably differ somewhat in regard to the west side.



Views of the Trimmingham Chalk Bluffs, Norfolk Coast.

(To illustrate Mr. R. M. Brydone's paper.)

In a paper on the last stage of the Glacial period in the Quart. Journ. Geol. Soc., 1874 (vol. xxx, p. 337), I maintained that subsequent to the last great glaciation of Scotland no submergence of the country has taken place beyond that slight change of level which is marked by the estuary beds and raised beaches a little above the present coastline. Along the shores of the Firth of Forth this change of level does not seem to me to have been more than about 30 feet. Such was also the opinion of Charles Maclaren, a careful and accurate observer, who spent a long life in that locality and knew it well. At the Firth of Tay the amount does not seem to be any greater, and on going farther north the change of level appears to me to become less. At Montrose, for example, it does not seem to exceed 15 or at most 20 feet. Between Montrose and Bervie the raised beach is well marked in many places, but I could see no trace whatever of any higher ones at 50 or 100 feet. On reaching Aberdeen the height is still less, apparently not more than eight or ten feet along the coast of that county, nor does it seem to be any more on the Banffshire coast. In the estuary of the Ythan, half-way between Aberdeen and Peterhead, the change of level can be well estimated and does not appear to exceed what I have stated. I have examined that locality carefully and repeatedly, but have never been able to perceive the least sign of a raised beach at either 50 or 100 feet.

In the valley of the Forth the old estuary-mud, or carse land, extends west a long way past Stirling, up to near the Loch of Menteith and Gartmore, rising gradually as we follow it inland to a level of 40 or 45 feet. This gradual rise seems to be always the case with a tidal mud as we trace it inland. The tidal wave rises often considerably in moving up a valley, as we see on the Severn at the present day. The fact of the carse land and alluvial loam of the Forth rising to 40 or even 50 feet at its inland extremity does not therefore imply a raised beach of that height at the coast. The Loch of Menteith is bordered by a fine group of old moraines which come down to the level of the carse, the lake itself being only 55 feet above the sea. These moraines were left during the retreat of the last great mantle of ice. Now, if there had been any subsequent submergence to the extent of 100 feet, it could not fail to have left its mark on the front of these moraines. The absence of anything of the sort is, I think, a proof that no such submergence has taken place. The basin of the lake should also have been filled with marine silt, of which there is no trace.

At Aberdeen we have moraines which come down close to the present beach, as for example at the Broadhill on the east side of the town. This Broadhill is one of the moraine heaps left by the glacier of the Dee during the last great extension of the ice. It is 94 feet high, and has been truncated apparently to some degree, or cut into, along its seaward side by the raised beach, but we look in vain for any evidence of sea-action upon it higher than a few feet above the present reach of spring tides. At Belhelvie, a few miles north of Aberdeen, we have another group of gravelly moraines left by the

glacier when it reached the coast. A submergence to the extent of 100 feet should surely have made some impression on these also. It was no small development of ice that brought the glacier of the Dee down to the coast when it left these moraines. During this last glaciation I believe the whole of Scotland was more or less covered with perennial snow and ice; but the ice was probably very thin in many places along the east side, where the thick streams descending from the Highland valleys had room to spread out freely. This would account for considerable portions of the older clay-beds having escaped destruction, and in point of fact some of these Belhelvie moraines overlie wasted masses of the clay.

If there was a raised beach at 100 feet we ought to find beds of estuary-mud with its characteristic fossils in our wider valleys near the 100 feet contour-line, but where are they? We have such beds with shells and whale-skeletons in these valleys at heights corresponding to the real old beach whose existence I have mentioned; but we have absolutely nothing of the sort corresponding to a submergence of 100 or even 50 feet. Is not this sufficient proof that there has been no such submergence? In Aberdeenshire the river Ythan (which enters the sea half-way between Aberdeen and Peterhead) flows along a wide little valley with a very small gradient, so that a submergence to the extent of 50 feet would send the tide ten miles up it. That basin should have certainly been filled to some extent with estuary silt, but no trace of anything of the sort is to be seen beyond a few feet above the limit of spring tides. A like submergence in the valley of the Dee would have sent the tide six or seven miles up that river with a similar result, and a submergence to the extent of 100 feet would have sent it on a few miles further; but no sign can be perceived of any such event having happened after the last glaciation which brought the Dee glacier down to the coast. Evidence of this sort could be multiplied along valleys on the east side of Scotland, but perhaps the above will suffice.

It would surely be time enough to talk of a hundred feet beach when we could point to some beds of littoral shells at a corresponding height, taking care that no shell heaps of edible mollusks left by man were mistaken for the real article, because on the shores of our estuaries such heaps are often to be found.

The notion of raised beaches at 50 and 100 feet seems to have arisen in 1879 in mapping Sheet 31 by the Geological Survey, for it is in the explanatory memoir of that sheet that we find this idea first brought forward, and ever since then it seems to have become a settled article of faith with the Scottish Survey. Beds of clay in the neighbourhood of Falkirk are described in that memoir having a flattish terraced aspect, which seems to have led to the belief that they were old beaches; but no good evidence, fossil or otherwise, is adduced to substantiate this opinion, and surely the mere flatness of a bed of clay is no sufficient proof that it is a beach. This clay was no doubt accumulated under water, possibly sea-water, but the evidence of denudation and disturbance which it shows in many places harmonizes better with the idea that it has been afterwards

exposed to the action of land-ice, which has moved over it with more or less damaging effect according to the thickness of that ice. We may consequently infer that the deposition of the clay took place previous to the last general glaciation. Such, it seems to me, is clearly the case with the red clay of Aberdeenshire, and the illustrations of disturbance in the beds at Portobello and elsewhere given by Mr. Geikie in his book convey the same impression. Moreover, such fossil evidence as these clays do present at Errol, Elie, Montrose, and other places points to deeper water than a submergence of even 100 feet would imply. I see no reason, therefore, to depart from my opinion that subsequent to the last general glaciation of Scotland there has been no submergence along the eastern side of that country beyond what would be accounted for by a depression of the land, amounting to from about 30 feet on the Firth of Forth to 10 feet on the coast of Aberdeen. The history of the Glacial period has proved a difficult subject to unravel, and we have all made mistakes about it. It is therefore in no captious spirit that I have been led to make these strictures on the raised beaches, but rather with the view of promoting a better knowledge of this passage in the last geological changes which our country has undergone.

Briefly, then, my reasons for disbelieving in the existence of these raised beaches at 50 and 100 feet on the east side of Scotland after the last general glaciation of that country are :—

1. Because at and below these levels there are moraine heaps which show no evidence of sea-action on them up to such heights.
2. Because there is an absence of estuary-mud with its characteristic fossils in the valleys at levels where such a submergence should have produced it.
3. Because there are no beds of littoral shells at levels corresponding to such beaches.
4. Because the beds of clay supposed to have been formed during the time of the 100 feet beach contain remains of mollusca and starfishes, which indicate deeper water and an older stage of the Glacial period.
5. Because these clays also show evidence of having been wasted and disturbed by subsequent glacial action, and are therefore anterior to the last general glaciation.

IV.—A Fossil Insect from the Coal-measures of Longton, North Staffordshire.

By Henry Woodward, LL.D., F.R.S., F.G.S.

SOME time since Mr. John T. Stobbs, F.G.S., obtained a very well-preserved impression in clay ironstone of the wing of a Neuropterous insect from the rich plant-bed at Foley, near Longton, North Staffordshire, which he very obligingly submitted to me for study. The geological horizon is that of the "Peacock Marl" (i.e., the marl overlying the Peacock Coal), and it therefore comes from near the top of the workable Coal-measures.[1]

[1] See letter by Mr. John T. Stobbs in Geol. Mag., 1903, p. 524.

The impression is that of the hinder wing of the left side of a Neuropterous insect, the wing being fully 5 cm. long and 2 cm. in breadth. The distal extremity is wanting, but from the scar left on the matrix the lost tip probably did not exceed 1 cm., and the point has been restored in dotted lines in the figure. At the point in the figure marked by a * the pinnule of a fern, *Neuropteris*, overlies the wing, but, for the sake of clearness, has been omitted from the drawing, and the nervures of the wing are continued by dotted lines over the obstacle; near the point of attachment to the body the structure of the wing is also obscured. For the convenience of description, small Roman numerals, marking the principal nervures, have been added to the figure of the wing (as used by Mr. Charles Brongniart).[1] The following is a brief description of the specimen as far as I am able to define it:—

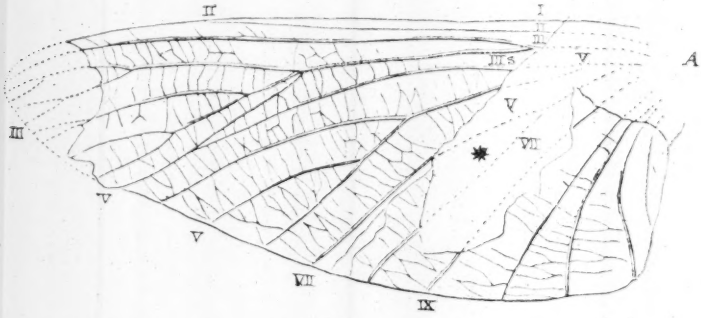


Fig. 1.—Left posterior wing of *Lithomantis carbonarius* (?), H. Woodw., from the Coal-measures, Foley, near Longton, North Staffordshire. I, the costal nervure; II, the sub-costal nervure; III, the radial nervure; V, the median nervure; VII, the cubital nervure; IX, etc., the anal or basal nervures.

The costal nervure (I) is strong, and forms the anterior margin of the wing; it gives off no branch. It is connected with the sub-costal (II) by a series of very fine straight nervules.[2] The costal and sub-costal converge distally at about two-thirds of their length from the body. The radius (III) runs in a parallel course for some distance from its commencement below the sub-costal, giving off a branch-nervure at III, *s*, one-third of its length, which, diverging rather more as it advances, is again subdivided at two-thirds of its length into three branches, the upper and middle ones subdividing again into two, and these into two more

[1] "Recherches pour servir à l'histoire des Insectes Fossiles des temps Primaires," etc., par Charles Brongniart; St. Etienne (Théolier et C^ie^), 1893. 4to; pp. 494, and Atlas, pp. 44, and 37 double 4to and folding plates. This accomplished naturalist, grandson of the celebrated botanist Adolphe Brongniart, died at the early age of 40 on April 18th, 1899, having, even in so few years, achieved much splendid work in fossil entomology. (See Geol. Mag., 1900, p. 430.)

[2] These fine straight nervules, not being easily seen, have not been shown by the artist in the above figure of the wing.

dichotomies before reaching the margin at III. The median nervure (V) commences singly at the base of the wing and gives off two branches; the upper one, curving slightly upwards, unites with the lower or third subdivision of III, *s*, and reaches the lower distal border at V; the lower branch subdivides into two, the upper nervure reaching the margin singly, the lower subdividing into two before ending about the middle or lower half of the posterior border; the cubitus (VII) is mostly hidden by the pinnule of a fern-leaf, but the direction it follows is indicated by a dotted line. It reaches the margin in two branches. Four anal or basal nervures follow, all of which are simple and have no dichotomies.

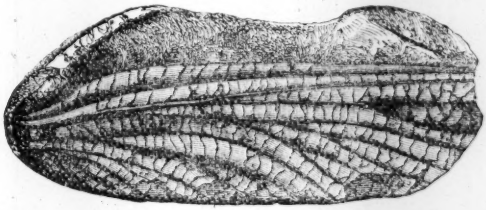


Fig. 2.—Wing of *Lithomantis* (*Corydalis*) *Brongniarti*, Mantell, sp. Coal-measures: Coalbrookdale, Shropshire.

I have already suggested[1] to the discoverer of this interesting specimen that it was probably nearly related to *Lithomantis carbonarius*, H. Woodward, figured and described by me (Quart. Journ. Geol. Soc., 1876, vol. xxxii, pp. 60–65, pl. ix, fig. 1) from the Coal-measures of Scotland, and also to the much earlier described wing of *Lithomantis* (*Corydalis*) *Brongniarti* (Audouin), G. A. Mantell, from Coalbrookdale.

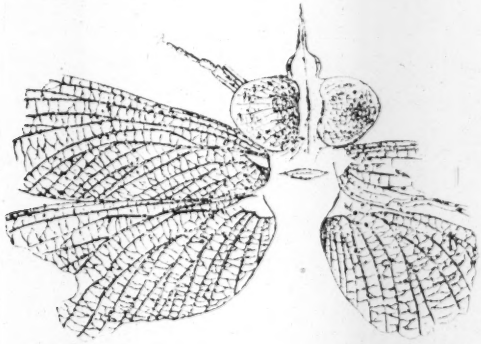


Fig. 3.—*Lithomantis carbonarius*, H. Woodw. Coal-measures: Scotland. One-third less than nat. size.

In his great work on the "Histoire des Insectes Fossiles des temps Primaires" (1893), M. Charles Brongniart has figured and

[1] Geol. Mag., 1903, p. 524.

described another fossil insect closely allied to the above, which he has there named *Homoioptera Woodwardi* [pl. xxxvi (20), fig. 10], but had originally described in 1890 (Bull. Soc. Philom. Paris, tome ii, pl. i) as *Lithomantis Woodwardi*, Brong. M. Brongniart,

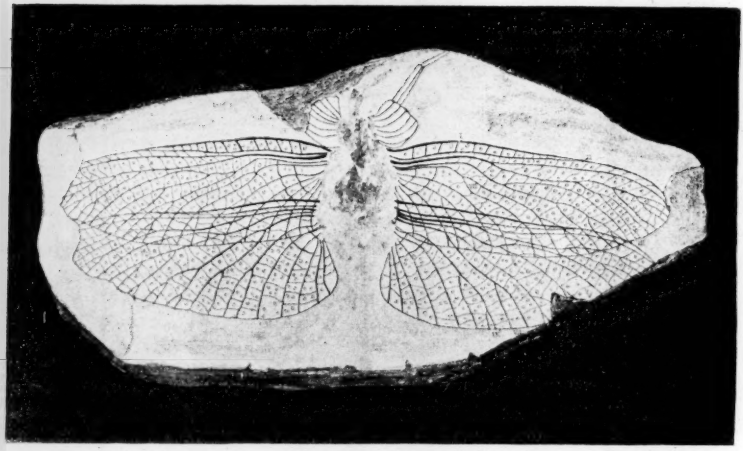


Fig. 4.—*Homoioptera* (*Lithomantis*) *Woodwardi*, Brong., 1890. Coal-measures: Commentry, France. One-half nat. size.

however, justified the adoption of the later generic name *Homoioptera*, on the ground that he found the Commentry insect did not actually agree with the living Mantidæ. But although they ought to be referred to different genera, they are not far removed from one another, and they both possess wing-like expansions on the prothorax. These forms, *Lithomantis*, *Fouquea*, *Homoioptera*, and thirteen other genera enumerated by M. Brongniart, are arranged by him under the family Platypterida.

He considers all these insects to be Neuroptera in their general characters; they attain to a large size, the smallest not being less than nine centimetres across the wings. They are all extinct forms, the group to which they may best be compared being the Ephemeridæ. They differ in the character of the nervation of their wings; the radius is not simple, but more or less dichotomising, as well seen in our Fig. 1 (III); furthermore, the second pair of wings are larger and more developed than the first pair, which is not the case in living Ephemera. These insects, as is common with nearly all the fossil genera, are only known to us (as a rule) by their wings, their bodies and limbs being extremely rare, and seldom found complete in the Coal-measures or in other old deposits yielding fossil insects.

It is doubtful whether the wing, now figured for the first time, from Mr. Stobbs' collection, is specifically distinct from *Lithomantis*

carbonarius, but it is certainly important to record its discovery in the Staffordshire Coalfield.

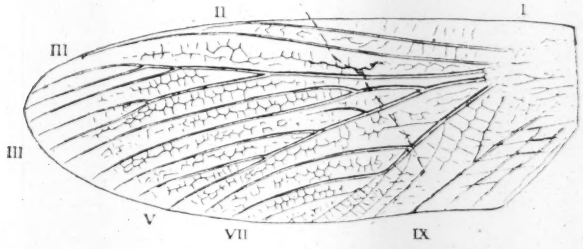


FIG. 5.—Wing of *Fouquea cambrensis*, n.sp., from the Coal-measures of South Wales. × 2. Reproduced from Mr. H. A. Allen's paper (see GEOL. MAG., 1901, p. 66).

It is very distinct in general form from *Fouquea cambrensis*, figured and described by Mr. H. A. Allen, F.G.S., from the Coal-measures of South Wales, but it certainly belongs to the same group as *Lithomantis* and to the family PLATYPTERIDA.

V.—ON THE PERMIAN AND TRIASSIC FAUNAS OF SOUTH AFRICA.

By Professor R. BROOM, M.D., D.Sc., Victoria College, Stellenbosch.

UNTIL recently very little attempt has been made to classify the reptilian fossils of the Karroo Beds according to their geological horizons. Seeley recognised certain zones—(1) the zone of Mesosaurs, (2) the zone of Pareiasaurs, (3) the zone of Dicynodonts, (4) the zone of specialised Theriodonts, and (5) the zone of Zanclodonts. While the order of these zones is correctly given they do not cover the whole period, and the third zone is an unnatural one.

As the result of the work of the last few years, it is now possible to subdivide the Karroo Beds with some degree of accuracy into a number of fairly well-marked distinct faunas. At the recent meeting of the British Association a paper was read, which will appear elsewhere, giving the details of recent work. As, however, much interest is at present being taken in the Triassic faunas of both Europe and America, a summary of the conclusions come to may be of use to workers in the northern hemisphere.

The most recent rocks of the Karroo Series are the Upper Stormberg Beds. These contain remains of the Dinosaurs *Massospondylus*, *Euskelesaurus*, and *Hortulotarsus*, and of the small crocodile *Notochampsa*. As *Notochampsa* is a true crocodile, we may safely refer the beds to Lower Jurassic, more especially as the Lower Stormberg or Molteno Beds immediately below have been referred by Seward from the evidence of the plant remains to the Rhætic.

Below the Molteno Beds we come to the *Cynognathus* Beds, corresponding to the 'specialised Theriodont' zone of Seeley. In

these beds there is a very rich fauna, of which the most characteristic forms are the extremely mammal-like Cynodont reptiles, *Cynognathus*, *Gomphognathus*, etc. Other noteworthy forms are the large Phytosaur, *Erythrosuchus*; the Gnathodont, *Howesia*, a small form allied to *Hyperodapedon*; a species of *Cyclotosaurus*, and a species of *Ceratodus*. There seems little doubt that these beds are of Upper Triassic age.

Underneath these we come to a distinct but allied fauna characterised by the abundant remains of the primitive reptile *Procolophon*. Other forms are *Paliguana*, the oldest known true lizard, and *Proterosuchus*, a Rhynchocephalian which shows some affinity to the Phytosaurs. These beds are called the *Procolophon* Beds, and may be of Middle Triassic age.

Below these are extensive beds in which land forms are very rare, but in which are abundant remains of the aquatic Anomodont, *Lystrosaurus*, and the fish *Atherstonia*. These are called the *Lystrosaurus* Beds, and they are believed to be of Lower Triassic age.

Underneath these *Lystrosaurus* Beds we come to rocks in which land forms are again numerous. Three fairly well-marked zones are recognised: (1) *Kistecephalus* Beds, (2) *Endothiodon* Beds, (3) *Pareiasaurus* Beds. In all of these remains of *Dicynodon* are met with, but it is in the *Endothiodon* Beds that *Dicynodon* and *Oudenodon* are met with in greatest abundance. All the carnivorous reptiles of this period are either Therocephalians or Dinocephalians. All three zones are believed to be of Upper Permian age.

Below the *Pareiasaurus* Beds a few reptiles have been found in the Ecca Beds, but most of the remains are very imperfect. *Mesosaurus* is found in the Upper Dwyka, and may be assumed to be of Lower Permian age.

While it is perhaps unwise to place too much weight on the evidence, the South African faunas seem to afford a little new light on the age of the Elgin sandstones. The *Stagonolepis* Beds, which contain *Stagonolepis*, *Ornithosuchus*, *Erpetosuchus*, *Stenometopon*, *Hyperodapedon*, and *Telerpeton*, seem to correspond to the *Cynognathus* Beds of South Africa, which contain *Erythrosuchus*, *Howesia*, and *Thelegnathus*, forms all allied to those of Elgin. If this be so, then the *Stagonolepis* Beds may be regarded as Upper Triassic.

The *Gordonia* Beds, containing *Gordonia*, *Geikia*, and *Elginia*, resemble most closely the *Pareiasaurus* Beds of South Africa with *Dicynodon*, *Oudenodon*, and *Pareiasaurus*. The resemblance, however, is much closer to the Russian forms of the Upper Permian of the Dwina, and it seems probable that the Elgin forms are descendants of the Russian, as the Russian probably are of the African. We may conclude that the *Gordonia* Beds are either Upper Permian or Lower Triassic, more probably the former.

(See also Abstract of paper by Prof. Broom on the Classification of the Karroo Beds of South Africa, p. 36.)

VI.—Remarks on the Irregular Echinoids of the White Chalk of England as exhibited in the British Museum (Natural History).

By C. Davies Sherborn, F.G.S.

HAVING been asked by Dr. Smith Woodward and Dr. Bather to look over the collection of Irregular Echinoids from the English Chalk in the British Museum with a view to bringing the exhibition up to date, it appears a favourable opportunity to say a few words as to the nomenclature and distribution of these animals.

Until Dr. A. W. Rowe has completed his study and given us the result of his examination of his own splendid collections, it is impossible to give more than a brief outline of the subject, for he, and he alone, has the material necessary for a detailed report. The bulk of the material in our National Collection has been acquired by donation or purchase, and that at a time when zones or localities were considered of little importance, whereas Dr. Rowe's material has all been collected by two persons, with the definite object of showing the evolution of the animals and the resulting progressive change into forms of more or less value. While, therefore, the National Collection is invaluable from a zoological point of view, it is practically valueless for Evolutional Palæozoology. The present exhibit has been obtained by the help of others, and the authorities have to thank Messrs. Bather, Chatwin, Dibley, Rowe, Sherborn, and Withers for specimens which show more or less completely the history of each species as it is followed successively upward in the zones of the White Chalk of this country. It has not been possible to acquire specimens from each zonal occurrence of the rarer species.

I will take the forms *seriatim*, making such notes as seem necessary as I proceed :—

Echinocorys scutatus, Leske : Addit. ad Klein, Nat. Dispos. Echin., 1778, p. 175, pl. xv, figs. A, B. This is the earliest name for this urchin. Leske does not say where the type came from, but it is a *cor-anguinum* form. The synonyms of this species are *E. ovatus*, Leske, Addit. ad Klein, etc., p. 178 ; *E. vulgaris*, Orbigny (*ex* Breyn), Pal. Franç. (Cret. Ech.), 1854, p. 62, pls. 805, 806. Range : *H. planus* zone to Danian.

Conulus albogalerus, Leske : Addit. ad Klein, Nat. Dispos. Echin., 1778, p. 162, pl. xiii, figs. A, B. This is the earliest name for this urchin. Leske does not say where his type came from, but it is a somewhat low (depressed) form from the *cor-anguinum* zone. The synonyms are *Galerites albogalerus* (Leske), Lamarck, Anim. sans Vert., iii, 1816, p. 20, and *Echinoconus conicus*, Orbigny (*ex* Breyn), Pal. Franç. (Cret. Ech.), 1860, p. 513, pl. 996. Range : *M. cor-testudinarium* to *A. quadratus* zones.

Conulus orbignyanus (Ag.). *Galerites orbignyana*, Agassiz, Mon. Ech. (*Galerites*), 1842, p. 22, pl. iii, figs. 5–8. This is the little bun-shaped *Conulus* found at Trimingham and in (?) the upper

part of the *mucronata* zone at Norwich. Brydone, in his "Stratigraphy and Fauna of the Trimmingham Chalk," 1900, p. 12, refers this to '*Echinoconus* (*abbreviatus*?),' but Dr. Bather has carefully gone into the matter with me and agrees that the determination with *orbignyanus* of Agassiz is correct. Range: (?) upper part of *B. mucronata* zone and the Danian Chalk of Trimingham.

Conulus globulus (Desor). *Galerites globulus*, Desor [*non* Leske], Mon. Echin. (*Galerites*), 1842, p. 18, pl. iv, figs. 1–4. Range: *Marsupites* zone.

Conulus subrotundus, Mantell: Geol. Sussex, 1822, p. 191, pl. xvii, figs. 15–18. Range: *T. gracilis* and *R. cuvieri* zones.

Conulus castaneus (Brongniart). *Nucleolites castaneus*, Brongniart, Géol. environs Paris, 1822, pl. ix, fig. 14. Range: *T. gracilis* and *R. cuvieri* zones.

Discoidea dixoni, Forbes. *Galerites* (*Discoidea*) *dixoni*, Forbes, in Dixon, Geol. Sussex, 1850, p. 341, pl. xxiv, figs. 13, 14. Range: *R. cuvieri* to *H. planus* (1 example) zones.

Micraster cor-anguinum (Leske). *Spatangus cor-anguinum*, Leske, Addit. ad Klein, Nat. Dispos. Echin., 1778, p. 221, pl. xxiii, fig. c (*anglicum*). Range: *M. cor-anguinum* to *B. mucronata* zones.

Micraster cor-testudinarium (Goldfuss). *Spatangus cor-testudinarium*, Goldfuss, Petref. German., 1829, p. 156, pl. xlviii, fig. 5. Range: *H. planus* to base of *M. cor-anguinum* zones.

Micraster præcursor, Rowe: Quart. Journ. Geol. Soc., vol. lv (1899), p. 530. Range: top of *T. gracilis* (1 example) to base of *M. cor-anguinum* zones.

Micraster leskei (Des Moulins). *Spatangus leskei*, Des Moulins, Etudes Echin., 1837, pt. 3, p. 392. Range: *R. cuvieri* to *H. planus* zones.

Micraster cor-bovis, Forbes: in Dixon, Geol. Sussex, 1st ed., 1850, p. 342, pl. xxiv, figs. 3, 4. Range: *R. cuvieri* to base of *M. cor-testudinarium* (2 examples) zones.

Epiaster gibbus (Lamarck). *Spatangus gibbus*, Lamarck, Anim. sans Vert., iii, 1816, p. 33. Range: *M. cor-testudinarium* (1 example) to *Marsupites*, and *B. mucronata* zones.

Infulaster excentricus (Rose). *Spatangus excentricus*, C. B. Rose, in Woodward, Geol. Norfolk, 1833, p. 37, pl. i, fig. 5. Range: *M. cor-anguinum* to *B. mucronata* zones (*teste* Cret. Rocks Brit., iii, Mem. Geol. Surv., 1904, p. 500). Recorded by Burnet (Geol. Mag., 1904, p. 175) from the *Holaster planus* zone of Lincolnshire. The type came from the Norwich gravels. Only known to Rowe and myself from the *M. cor-anguinum* zone; not seen from *Marsupites* or *A. quadratus* zones; not in the Fitch Collection, and not found by us in the *B. mucronata* zone at Norwich or elsewhere. If a specimen were found below the *M. cor-anguinum* zone, we should suspect it to be *Cardiaster cotteauanus*, but the material yet known is not sufficient to work out the relationships and differences of these two forms.

Hagenowia rostrata (Forbes). *Cardiaster rostratus*, Forbes, Fig. Brit. Org. Rem., Mem. Geol. Surv. U.K., dec. iv, 1852, p. 3, pl. x. *Infulaster rostratus*, Wright: Pal. Soc. (Cret. Ech.), 1881, p. 307. *Hagenowia rostratus*, Duncan: Journ. Linn. Soc. (Zool.), xxiii, 1889, p. 211. Range: *M. cor-testudinarium* (1 example, Yorkshire) to *A. quadratus* zones.

Hemiaster minimus (Agassiz). *Micraster minimus*, Agassiz, Echin. Suisse, i, 1839, p. 26, pl. iii, figs. 16–18. Range: *R. cuvieri* to *M. cor-testudinarium* zones.

Holaster planus (Mantell). *Spatangus planus*, Mantell, Geol. Sussex, 1822, p. 192, pl. xvii, figs. 9 and 21. Range: top of *R. cuvieri* (1 specimen) to base of *M. cor-testudinarium* zones.

Holaster placenta, Agassiz: Cat. Syst. Ect. Ech., 1840, p. 1; Modèle 2; Ann. Sci. Nat. (3), viii, 1847, p. 27. Range: top of *R. cuvieri* (1 specimen) to *A. quadratus* zones. Very rare except in the *Micraster* zones.

Cardiaster ananchytis (Leske). *Spatangus ananchytis*, Leske, Addit. ad Klein, Nat. Dispos. Echin., 1778, p. 243, pl. liii, figs. 1, 2. Range: *M. cor-anguinum* (1 specimen) to Danian. Common in *quadratus* chalk, Yorkshire; common in *mucronata* chalk, Norwich.

Cardiaster pygmæus, Forbes: Ann. Mag. Nat. Hist. (2), vi, 1850, p. 444 (name only); Forbes, Fig. Brit. Org. Rem., Mem. Geol. Surv. U.K., dec. iv, 1852, p. 4. Range: *R. cuvieri* zone.

Cardiaster cotteauanus, Orbigny: Pal. Franç. (Cret. Ech.), 1855, p. 140, pl. 830. Range: *H. planus* and *M. cor-testudinarium* zones.

Cardiaster cretaceus (Sorignet). *Holaster cretaceus*, Sorignet, Oursins fossiles Eure, 1850, p. 69. Range: *R. cuvieri* and *T. gracilis* zones.

Offaster pilula (Lamarck). *Ananchytes pillula* (sic), Lamarck, Anim. sans Vert., iii, 1816, p. 27. Range: *Marsupites* (2 or 3 known), *A. quadratus* zone (common); known from *B. mucronata* zone.

The information as to range has been obtained from Rowe and Sherborn's papers on the White Chalk in the Proc. Geol. Assoc., 1900–1904 (see Index to, etc., idem, vol. xviii, pt. 7, 1904, pp. 375–384), and Dr. Rowe's unpublished notes; and the exact distribution and history of the genus *Micraster* can be seen in Quart. Journ. Geol. Soc., vol. lv (1899), pp. 494–546. I have received much assistance from Dr. Bather during the progress of this work.

VII.—Lists of Wenlockian Fossils from Porthluney, Cornwall; Ludlowian Fossils from Porthalla; and Taunusian Fossils from Polyne Quarry, near Looe, Cornwall.

By Uffield Green, F.G.S., and C. Davies Sherborn, F.G.S.

In the Autumn of 1904 we had the good fortune to find in the "Slates with inclusions" at Porthluney, near Gorran, Cornwall, a lenticle of limestone which has yielded a small but satisfactory series of forms allowing its reference to the Wenlockian beds.

In the Geological Magazine, July, 1904, p. 289, one of us had the pleasure of recording the occurrence of Ludlow fossils at this spot in the same beds, and that discovery renders the present one of additional interest. The fossils, which have been handed over to the Geological Survey, are as follows:—

Ptilodictya lanceolata, Lonsd.
Fenestella assimilis, Lonsd.
Fenestella cf. B.M., D 571, from Wenlockian of Dudley.
Fenestella sp.
Millepora cf. *repens* (L.).
Monticuliporid, ramifying through the whole mass of the lenticle.
Rhynchotreta cuneata (Dalm.).
Amphicœlia striata (Sow.).
Pterinæa sp.

In the Autumn of 1905 we again visited Porthalla, and after working three days found another fossil in the "Slates with inclusions" on the beach of Nare Cove. This was a pyritized *Orthoceras* comparable with *O. bullatum*, Sow., and *O. virgatus*, Sow., both of Ludlow age, and distinct from the forms found similarly mineralized in the Devonian beds, by reason of the casts of its siphuncular chambers being barrel-shaped instead of parallel-sided. It is preserved in the British Museum and registered as B.M., C 10529.

Three days work at Polyne Quarry, in the Taunusian beds, yielded thousands of fossils. The bulk of these are in so bad a state that it is difficult to recognize even the genus, but careful collecting and a knowledge of the better specimens to be obtained in Germany render it a comparatively easy task to select sufficient identifiable examples. The following list shows the fossils obtained, the more interesting of which have been placed in the British Museum (Nat. Hist.):—

Fenestella.
Pachypora.
Petraia pauciradiata (Phillips). B.M., R 7502, 7503.
Petraia celtica (Lamouroux). B.M., R 6079.
Petraia radiata, Muenster. B.M., R 7496, 7561.
Petraia punctatocrenulata, Roemer. B.M., R 6978.
Petraia gigas, McCoy. B.M., R 2833, 613.
Pleurodictyum problematicum, Goldfuss. B.M., R 6072, 6973.
Lodanella mira, Kayser. B.M., P 7697.
Neritopsis. A fine series, some showing a broad expanded mouth. B.M., A 1158–1160.
Phacops ferdinandi, Kayser. Six quite typical eyes, one of which showed part of the head-shield. B.M., I 7233, 7234.
Strophodonta gigas, McCoy.
Streptorhynchus.
Athyris cf. *undata*, Defr.
Rhynchonella.
Rensellæria.

Orthis personata, Zeill.
Orthis vulvaria, Schl.
Orthis circularis, Sow.
Spirifer primævus, Stein.
Spirifer subcuspidatus, Schnur.
Spirifer cf. *hystericus*, Schl.
Crinoid columnars, some very large, ¾ inch across. B.M., E 14062.

The *Lodanella*, which was obtained by the last drive of the crowbar, is magnificent and quite equal to the type-specimen.

It is hoped that these lists will stir up others to search for fossils in this interesting area. We are much indebted to Mr. G. C. Crick and Mr. W. D. Lang, who have most carefully examined and helped us with some of our material.

NOTICES OF MEMOIRS, ETC.

British Association for the Advancement of Science. Meeting in South Africa, August 15th to Sept. 1st, 1905. Papers read before Section C, Geology.

I.—On the Relation between Ore Veins and Pegmatites. By Professor R. Beck.

THE author gave a summary of the latest investigations on the origin of pegmatites, by W. C. Brögger, H. Rosenbusch, S. Arrhenius, J. H. L. Vogt, U. Grubenmann, and others. In conformity with these authors, he explained pegmatites as products of crystallisation from the superheated water, which remained, after the consolidation of a plutonic magma, as a concentrated solution containing many of the rarer chemical elements and compounds formerly distributed through the whole fluid mass. Being retained in the depths of a plutonic focus under high pressure, these remains of magmatic water could pass through a very gradual process of cooling; whereas the so-called 'juvenile' thermal waters (*Juvenile Quellen*) of similar origin found their way to the upper parts of the earth's crust, and caused there the formation of minerals at lower temperatures and pressures.

Most ore veins belong to the second class, but a considerable number of occurrences may be styled metalliferous pegmatites.

The best known examples of these are found in the group of tin ores, and as such were discussed the ore veins of Zimwald, Graupen, Embabaan, and others.

As examples of copper ores were cited those of Telemarken in Norway; and finally some gold-bearing quartz reefs were described which are very nearly related to pegmatites, and that not merely by their characteristic mineralogical composition (Berezowsk, Southern Appalachians, Yukon District, Passagem, and other instances in Brazil). It may be mentioned in proof of this that certain gold quartzes contain tourmaline, the characteristic mineral of all pegmatites.

II.—The Classification of the Karroo Beds of South Africa. By Professor R. Broom, M.D., B.Sc.

AN attempt is made from the study of fossil remains to give a more satisfactory subdivision of the Karroo System than has hitherto been possible. The larger subdivision into the Dwyka, Ecca, Beaufort, and Stormberg Series is retained.

The Beaufort Beds are divided into series. The lowest is characterised by the presence of Therocephalians and Anomodonts. These lower beds can be again divided into an earlier series, in which occur *Pareiosaurus* and *Titanosuchus*, and a later series characterised by the prevalence of *Dicynodon* and *Oudenodon*.

Above the Lower Beaufort Beds occur a Middle series, characterised by the rarity of reptilian remains other than of *Lystrosaurus*, which is very abundant.

The Upper Beaufort Beds are characterised by the presence of the Theriodonts. In the earlier subdivision of these upper beds *Procolophon* is the most characteristic fossil, and in the upper the Theriodont *Trirachodon*.

The Stormberg Beds appear to be divisible into two groups—a lower, the Molteno Beds, and an upper, which includes the Red Beds, the Cave Sandstone, and the Volcanic group.

The Dwyka and Ecca Series are believed to represent the Lower and Middle Permian of Europe, and the Lower Beaufort Beds the Upper Permian.

The Middle Beaufort and Upper Beaufort Beds are believed to correspond to the Lower and Upper Trias of Europe.

The Stormberg Beds are believed to be Lower Jurassic or Rhætic, and the Upper Stormberg Beds Lower Jurassic.

III.—The Stormberg Formation in the Cape Colony. By Alex. L. du Toit, B.A.

THE Stormberg Formation is the uppermost division of the Karroo System in South Africa, and builds up the whole of Basutoland and the adjoining portions of the Cape Colony, the Orange River Colony, and Natal. In the Cape Colony the tract occupied by this formation is confined to the immediate neighbourhood of the Drakensberg Range, widening out considerably in the south-west over what is known as the Stormberg area.

The Stormberg series is subdivided as follows in downward succession :—

(4) Volcanic Beds,
(3) Cave Sandstone,
(2) Red Beds,
(1) Molteno Beds.

The strata lie nearly horizontally, or are only inclined at low angles, consequently the lower divisions crop out along the foot of the mountain ranges, while the upper beds form all the higher ground. The Molteno Beds consist of a thickness of 1000–2000 feet of sandstones, with thin, dark shales and mudstones and occasional

coal-seams. Arenaceous material is predominant, and the sandstones vary from fine-grained grey felspathic varieties to coarsely crystalline 'glittering' sandstones, with small pebbles of vein-quartz. Boulders of hard white or brownish quartzite, derived evidently from the Cape Formation, are common, usually scattered irregularly throughout the sandstone beds, but occasionally forming conglomerate bands. The coals are thin, and contain from 15 to 30 per cent. of ash, but are the only workable deposits in the Cape Colony. Fossils are almost entirely those of plants, e.g., *Thinnfeldia, Tæniopteris, Callipteridium*, etc., from which the Rhætic age of the beds has been deduced.

The Red Beds are more argillaceous in character, and consist of 600–1600 feet of strata, in which red and purple shales, mudstones, and sandstones are predominant, though thick beds of fine-grained white sandstone are also common. Fossil remains are chiefly those of carnivorous Dinosaurs, such as *Euskelesaurus* and *Massospondylus*.

The Cave Sandstone is a thick bed of fine-grained felspathic sandstone, usually white or yellowish in colour, and of very striking appearance. As a rule, it is unbedded throughout, except towards its summit, or less commonly towards its base. In some places it attains a thickness of 800 feet, but as a rule it varies from 150 to 350 feet. In a few places the Cave Sandstone is entirely absent, and the volcanic beds rest directly upon the red beds. The Cave Sandstone weathers into most fantastic outlines, and gives rise to very peculiar scenery along the Drakensberg.

The sediments of the Karroo System were deposited in a great inland sea, 'the Karroo Lake,' in which the water was either fresh or slightly brackish, and not very deep. During the formation of the Stormberg rocks the shore-line stretched where the coast ranges of the south of the Colony now rise, and extended eastwards into the Indian Ocean, and then north-eastwards parallel to the coastline of Natal. This old land surface was formed of rocks belonging to the Cape and Pre-Cape Systems, quartzites, granites, and metamorphic rocks.

During Cave Sandstone times volcanoes came into existence, and great eruptions of basic lavas took place. Over 100 volcanic necks have been mapped by the Geological Survey, some of which are over a mile in diameter. Many of the pipes are filled with siliceous breccias, or with fine-grained sandstone-like tuffs. The erupted material consists almost entirely of basic lavas, compact to vesicular, the most interesting variety of the latter being the 'pipe-amygdaloid'; enstatite-andesites occur in a few places. Beds of volcanic ash are met with in Barkly East and around Jamestown. In the former district there are frequent alternations of lava, ash, and sandstone, the even bedding and passage of sandstone into ash, either laterally or vertically, pointing conclusively to sub-aqueous eruptions. The later flows were probably subaerial.

At the close of the volcanic outbursts, after 2000–5000 feet of lavas had been erupted, the area was affected by gentle folds by which the direction of flow of the Kraai and Orange Rivers was

determined. Then followed the gigantic and extensive intrusions of dolerite, which at the present day form such a conspicuous feature in the scenery of the Karroo.

The interior of the colony was intermittently elevated, and the old land surface in the south disappeared beneath the waters of the Indian Ocean. A series of peneplains, or plains of river-erosion, mark the periods of rest and elevation of the country, the highest of which is now found at an altitude of a little over 8,000 feet above sea-level. The plateau of the Drakensberg has been deeply cut into on the west and south-west, but on the south-east it presents an almost unbroken face, over 300 miles in length, rising from 2,000 to as much as 6,000 feet above the ground at its base.

IV.—Index Generum et Specierum Animalium.—Report of a Committee, consisting of Dr. Henry Woodward (Chairman), Dr. F. A. Bather (Secretary), Lord Walsingham, Dr. P. L. Sclater, Rev. T. R. R. Stebbing, Dr. W. E. Hoyle, and the Hon. Walter Rothschild.

SATISFACTORY progress has been made by Mr. David Sherborn in the recording of literature from 1801 onwards. Among other works now indexed up to 1850 may be mentioned the "Annals and Magazine of Natural History," the "Academia Cæsarea," and the "Neues Jahrbuch für Mineralogie." Various tracts dealing with the collation of difficult books have been issued, and a reprint of the descriptions of new species of birds drawn up by Pallas for "Vroeg's Catalogue," 1764, has been published by the Smithsonian Institution, under Mr. Sherborn's care, from the unique copy in the Linnean Society's Library. The search for rare books still continues, and any such acquisitions are made available for public use by transference to one or other of the accessible libraries. Special thanks are due to the Italian Government, the University of Padua, and Professor Dante Pantanelli for enabling the Committee to examine the "Tavola alfabetica delle conchiglie adriatiche" of Stefano Andrea Renier (1804). Help of this nature, as well as valuable criticism, is continually forthcoming from home and abroad, and the general interest taken in the published volume (1758–1800) is highly gratifying to Mr. Sherborn and satisfactory to this Committee, which, in this connection, desires to return its thanks especially to Mr. L. B. Prout and Mr. C. W. Richmond.

REVIEWS.

I.—Mesozoic Plants from Nagato and Bitchu. By M. Yokoyama. (Journ. Coll. Sci. Univ. Tokyo, vol. xx, art. 5, pp. 13, and 3 pls. 1905.)

PROFESSOR YOKOYAMA has continued his studies of the Mesozoic floras of Japan, and in the present communication confirms his previous conclusion as to the Rhætic age of the fossil plants of the Coal-bearing series of Nagato. Eight species are

described, including such well-known Rhætic fossils as *Cladophlebis nebbensis* (Brongt.) and *Polozamites lanceolatus* (L. & H.). Several other specimens, mostly fragmentary, are figured from the province of Bitchu and are probably of similar age. A number of excellent figures of most of the species described are given. E. A. N. A.

II.—New Species and a New Genus of Batrachian Footprints of the Carboniferous System in Eastern Canada. By G. F. Matthew, D.Sc., LL.D. Trans. Roy. Soc. Canada, ser. II, vol. x, sec. 4, pp. 77–110, with 5 plates, 1904–1905.

THIS article contains descriptions of species that more fully present the characters of the genera described from the type species in an article published last year in the Canadian Record of Science, Montreal. It also contains descriptions of the new genus *Dromillopus*, founded on the footprints of a small Batrachian of the Coal-measures of Joggins, Nova Scotia.

This article also refers the species *Dromopus celer* of the preceding article provisionally to Woodworth's genus *Batrachichnus*.

The full descriptions of the genera and species described in the article in the Canadian Record of Science are here re-presented, with additional notes.

Six plates of figures accompany this article and show clearly the generic and specific characters of the species of footprints described.

In conclusion, the writer makes comparisons of these footmarks with those of the frog and the alligator, and finds that they show closer resemblances to those of the latter than to the footsteps of the former, but he concludes that there are peculiarities of form in the fossil footprints not to be found in either of the recent forms used for comparison, and that Labyrinthodonts and Microsauria are responsible for many of these tracks.

III.—Rocks of Cape Colville Peninsula, New Zealand. By Professor Sollas, F.R.S. With an Introduction and Descriptive Notes by Alexander McKay, F.G.S., Government Geologist, New Zealand. Vol. I. pp. 289. (Wellington, 1905.)

THIS volume on the rocks of Cape Colville Peninsula is chiefly devoted to the description by Professor Sollas of the specimens which were submitted to him by the New Zealand Government. Some diversity had arisen in the nomenclature of the igneous rocks which are the source of the gold in the Thames Goldfield, and it was decided to obtain an authoritative opinion by submitting a selection of the rocks to a competent petrologist. The principal object of the report is therefore to place on a satisfactory footing the nomenclature of the rocks of the Peninsula.

The present volume contains only the descriptive notes on the first 204 specimens sent to Professor Sollas. That he is not responsible for the form in which they are published is evident from a somewhat pathetic footnote on p. 126, in which he disclaims responsibility for

their literary style. As almost all the rocks belong either to the Andesite or Rhyolite group, the detailed petrographical notes given of each individual specimen certainly prove somewhat monotonous reading. Professor Sollas himself states that the substance of the report may be regarded as mere statement of matter of fact: we have hopes, however, that these 'dry bones' may yet live, since he holds out the expectation of a more comparative study for the final report, in which also the question of the origin and structure of spherulites will be considered.

In a general note preceding the systematic descriptions of the specimens we have a foretaste of this final report in some interesting remarks on the nature of the 'pilotaxitic' matrix of the andesites, and also on the supposed re-fusion of rhyolites, for which Professor Sollas finds no evidence, since the so-called felspar-'glass' is really only a decomposition product.

To supplement the descriptions of the specimens an introductory and explanatory account of the geological position of the rocks is given by Mr. McKay.

Perhaps the most remarkable feature of the volume is the wealth of illustrations; plates of photographs of scenery and of micro-photographs of the thin slices of the rocks are almost interleaved with the letterpress.

IV.—Geology in the Federated Malay States.

BY the kindness of a friend we have seen several Reports issued by this Government, but as copies have not been sent to the Library of the British Museum (Nat. Hist.) we are unable to give a comprehensive notice of the whole of the work done. Those Reports before us are No. 8, dealing with the Geology of the Residency of Sarawak, and of the Sadong District, Borneo,[1] and the Geologist's Report for 1904.[2] Mr. J. B. Scrivenor, the geologist to the Federated Malay States, after acknowledging help obtained from the staff of the British Museum (Nat. Hist.) in the naming of fossils found, reports on his journey through the areas of the four Federated States. He describes the serpentine areas of Kuala Pilah and Negri Sembilan, some of which is used for road-metal and some for ornaments. He failed to find a trace of platinum, the object of his search. Ornamental building-stone seems to be abundant, and the granites would work up on a large scale. The occurrence of tin is next dealt with and occupies the bulk of the Report. The main object of the visit to Sarawak and Borneo was economic (gold and coal). Mr. Scrivenor gives a brief but careful sketch of previous work, and proceeds to make supplementary notes. The coal-seam at Sadong is 2′ 9″ in thickness, but varies considerably. It is a black bituminous coal, light in weight and easily fractured, and contains a considerable amount of calcite and some pyrites locally. It burns well and leaves little ash, but owing to its friable nature

[1] Geol. Dept. F.M.S. (Kuala Lumpur), 1905, 12 pp.
[2] Ibid., 7 pp.

the furnace bars have to be especially arranged. Gold is worked down to 93 and 120 feet, and details are given of the various deposits now opened. As for the geology of Sarawak, the author refers to the papers of R. B. Newton in the GEOLOGICAL MAGAZINE, while for the whole island the works of Molengraaff and Verbeek are the standard books of reference. The Tertiary and Secondary rocks are now well made out, but as yet fossils from the Primary rocks do not seem to have been found. Mr. Scrivenor was appointed for three years, but we hope his time will be considerably extended in order that he may have an opportunity of finishing what promises from these two reports to be a valuable piece of surveying.

REPORTS AND PROCEEDINGS.

GEOLOGICAL SOCIETY OF LONDON.

I.—November 22nd, 1905.—J. E. Marr, Sc.D., F.R.S., President, in the Chair.

A Special General Meeting was held before the Ordinary General Meeting at which Horace Woollaston Monckton, Treas. L. S., was elected Treasurer, and Richard Hill Tiddeman, M.A., was elected a Member of Council.

The following communications were read:—

1. "On a New Specimen of the Chimæroid Fish, *Myriacanthus paradoxus*, Ag., from the Lower Lias of Lyme Regis (Dorset)." By Arthur Smith Woodward, LL.D., F.R.S., F.L.S., F.G.S.

The author, having proved that the dorsal fin-spine of the so-called *Ischyodus orthorhinus* is identical with an ichthyodorulite which has been named *Myriacanthus granulatus*, inferred that the larger ichthyodorulite *M. paradoxus* belonged to the same fish as the larger dentition named *Prognathodus Guentheri* by Egerton. This question has been settled by the discovery by Mr. S. Curtis, in the Lower Lias of Black Ven, of a dorsal fin-spine in direct connection with a mass of decayed cartilage, dermal plates, and teeth. On the specimen the following parts are recognised:—the left and left palatine dental plates, right mandibular dental plate, cartilage of the pectoral arch, præsymphysial tooth, rostal cartilage, frontal spine or tentaculum, and vomerine dental plate, dermal plates, and the dorsal fin-spine. The new fossil warrants the conclusion that *Myriacanthus* is a Chimæroid, closely similar to the Upper Jurassic *Chimæropsis*, with (i) a median chisel-shaped tooth in front of the lower jaw, (ii) a few tuberculated dermal plates on the head, and (iii) a tuberculated dorsal fin-spine. In these respects it differs from all other known Chimæroids—even from the comparatively primitive types which have been discovered during recent years in the Japanese seas. The Myriacanthidæ, in fact, have still no nearer ally than *Callorhynchus*, with which Egerton originally compared his so-called *Ischyodus orthorhinus*.

2. "The Rocks of the Cataracts of the River Madeira and the adjoining portions of the Beni and Mamoré." By John William Evans, D.Sc., LL.D., F.G.S.

The crystalline rocks of the cataracts of the River Madeira and the lower waters of its tributaries are part of a ridge with a north-westerly and south-easterly strike, similar to that of the Andes, in the same latitudes. The strike is especially prevalent in Equatorial regions. With the exception of comparatively recent alluvial deposits and a few pebbles of chert, pronounced by Dr. G. J. Hinde to be of marine origin but uncertain date, only crystalline rocks are met with in the falls. They all appear to be igneous, and are mostly massive in character, though some dyke-rocks occur. In places they are typical gneisses, and they are often banded, but in some cases they show no sign of foliation. The prevailing type is acid, with a considerable proportion of alkalies, especially soda; but some of the rocks are distinctly basic in character. Analyses of several of these rocks, made by Mr. G. S. Blake, are tabulated; and in one case the chemical analysis is compared with one made from the proportion of minerals washed out from the thin sections. Accounts of the megascopic and microscopic characters of all the rocks encountered are given. The more acid rocks are usually fine in grain, and are often granulitic in structure. In most cases the quartz seems to have crystallized out before the felspar. The occurrence of andalusite of chiastolitic type and of sillimanite as inclusions in a felspar is referred to, as well as the presence in one rock of an unusual type of allanite. An altered basalt is described, which contains minute concentric structures allied to those of a pyromeride. Above and below the regions of the cataracts is a wide expanse of country covered with alluvium, either of recent or later Tertiary date.

3. "The Doncaster Earthquake of April 23rd, 1905." By Charles Davison, Sc.D., F.G.S.

The Doncaster earthquake of 1905 was a twin, with its principal epicentre half a mile north of Bawtry, and the other about four miles east of Crowle and close to the centre of the disturbed area of the Hessle earthquake of April 13th, 1902. The distance between the two epicentres is about 17 miles. The disturbed area contains about 17,000 square miles, including the whole of the counties of Lincoln, Nottingham, Derby, Stafford, Leicester, and Rutland, the greater part of Yorkshire, and portions of Lancashire, Cheshire, Shropshire, Worcestershire, Warwickshire, Northamptonshire, Cambridgeshire, and Norfolk. The originating fault runs from about E. 38° N. to W. 38° S., and appears to be nearly vertical within the south-western focus and inclined to the south-east in the north-eastern focus. The first and stronger movement took place within the south-western focus. A twin earthquake is probably due to the differential growth of a crust-fold along a fault which intersects it transversely, the first movement as a rule being one of rotation of the middle limb, accompanied by an almost simultaneous slip of the two arches, and followed soon afterwards by a shift of the

middle limb. The movements in which the Doncaster earthquake originated presented a slight variation in this order. They consisted of successive but continuous displacements, first of the south-western arch, then of the middle limb, and finally of the north-eastern arch.

II.—December 6th, 1905.—J. E. Marr, Sc.D., F.R.S., President, in the Chair. The following communications were read :—

1. "The Physical History of the Great Pleistocene Lake of Portugal." By Professor Edward Hull, LL.D., F.R.S., F.G.S.

The formations bordering the lower banks of the Tagus near Lisbon are arranged by the author in the following order of succession :—

6.	Recent and Quaternary.	Alluvia of the Tagus.
5.	Lacustrine.	Marls with *Lymnæa* (Lacustre superior). Sands and gravel.
4.	Post-Pliocene and Pliocene.	Not represented, unless by some land-glacial beds due to elevation.
3.	Miocene.	'Almada Beds.' Calcareous marls and limestones, with marine fossils.
2.	Eocene (?).	Unfossiliferous sands and gravels (Lacustre interior).
1.	Upper Cretaceous.	Hippurite Limestone.

A description is given of the Lacustre superior; the Almada Beds are considered to be Miocene, and as the Pliocene is not represented, except possibly by certain glacial deposits, the author considers that that period was one of great uplift, when the suboceanic gorge, an extension of the present course of the River Tagus, was excavated. The margin of the lake was probably formed by the granite of Das Vargans and Cunheira. There is evidence that the general level of the lake-bed was nearly that of the outer sea, and that the sea-waters gained occasional access to the lake during the earlier stage of its formation. The lake was eventually drained by the channel cut by the Tagus at the harbour of Lisbon, upon the elevation of the land to about its present level.

2. "The Geological Structure of the Sgùrr of Eigg." By Alfred Harker, M.A., F.R.S., F.G.S.

The pitchstone which forms the Sgùrr of Eigg is a massive sheet, some 400 feet thick, reposing with discordance upon the succession of alternating basalts and dolerites which make up the greater part of the island. The lower surface of the pitchstone is irregularly undulating, and in two places fragmental accumulations are seen immediately beneath it. The generally received interpretation regards the pitchstone as a lava-flow, or series of flows, occupying an old river-valley excavated in the basalts, and the fragmental deposits have been regarded as river-gravels of the pitchstone age. This is the view put forward by Sir Archibald Geikie.

After a detailed survey of the ground, the author finds it impossible to accept this view, and he gives reasons for considering the pitchstone to be intrusive. The form of its base, as mapped out, does not seem to be reconcilable with that of a river-valley,

and its character is that of an intrusive junction rather than an erosion surface. The fragmental deposits are believed to be of volcanic origin and of the basalt age. The one exposed at the seaward termination of the ridge is a volcanic agglomerate, probably filling a small vent. The other, seen at the southerly base of the Sgùrr, is a bedded agglomerate, partly rearranged by water action. The Torridonian and Oolitic sandstone blocks which are abundant in it are held to have been brought up from below, and fossil wood of Oolitic age has been brought up in the same manner. The absence of fragments of the sill-dolerites (themselves younger than the lavas, but cut off by the pitchstone) in both accumulations seems to assign them unequivocally to the age of the basalt, and their conjunction with the pitchstone must then be considered accidental.

The conclusions arrived at bring the rock of the Sgùrr of Eigg into relation with the other British Tertiary pitchstones, which are all intrusive. Thus also is avoided the difficulty of assuming a great erosion in inter-volcanic times, a hypothesis for which the supposed river-valley was the sole evidence.

Dr. J. W. Evans, in showing a new method of determining the optic axial angle of a biaxial mineral, by rotating it in parallel polarized light, on an axis at right angles to the optic axial plane and to the axis of the microscope, said that the position in which the relative retardation was zero corresponded to the optic axes, and the angle between these positions was the optic axial angle in air or in the medium in which the mineral was immersed. To determine when the relative retardation is *nil* the nicols are placed at angles of 45° with the axis of rotation; the double wedge described in the Mineralogical Magazine for May last (vol. xiv, p. 29) is then inserted, and the position noted when the bands on the two halves of the wedge are in exact continuation of one another.

This method is applicable to sections of minerals in rock-slides which are cut at right angles to the optic axial plane; for the observation can be made with a low power, which admits of the slide being freely rotated in a stage goniometer. With the higher powers which are necessary for microscopic observations in convergent light, a rock-slide could only be rotated within very narrow limits.

Dr. F. A. Bather exhibited fossils from various localities in New Zealand, hitherto known as "the Mount Torlesse Annelid," described in the Geological Magazine (December, 1905, p. 532). Adds further information thereon; for which see his letter, p. 46 below.

III.—Mineralogical Society of London.

November 14th, 1905; Professor H. A. Miers, F.R.S., President, in the chair. — The Determination of the Angle between the Optic Axes of a Crystal in Parallel Polarised Light, by Dr. J. W. Evans. The crystal plate is rotated on the optic normal as axis, and the positions are determined in which the relative

retardation is *nil*. This may be observed by using a gypsum plate or the double quartz wedge devised by the author. In the latter case the positions in question are marked by the coincidence of the bands in the two halves of the wedge. This gives a very exact reading if strictly parallel light be employed.—Mineralogical Notes (Diopside and Albite), by Professor W. J. Lewis. A large tabular crystal of white diopside, a brown diopside of unusual habit, and a Carlsbad twin of albite were described.—Note on the Crystallisation of Drops, especially of Potash-alum, by Mr. J. Chevalier. The President described observations made by Mr. Chevalier on the crystallisation of drops of solution of potash-alum. These generally yield in succession (*a*) birefringent spherulites, (*b*) octahedra, and (*c*) a fine rectangular network. (*a*) is probably a less hydrated alum, and it becomes isotropic on exposure to moist air by conversion into (*b*). (*c*) is ordinary alum which is in a state of strain, owing to its rapid crystallisation, and becomes white and opaque after a time owing to the development of cracks. Drops observed upon a slide under the microscope behave differently according as they are in the metastable or labile condition. A metastable drop inoculated with (*a*) or (*b*) or (*c*) deposits octahedra. A labile drop inoculated with (*a*) deposits spherulites, but inoculated with (*b*) or (*c*) deposits the rectangular network. When a metastable drop containing either octahedra or spherulites, or both, passes into the labile condition (by cooling or by evaporation) they may continue to grow unchanged. If, however, a fragment or germ of octahedral alum be introduced into a labile drop, the network (*c*) is immediately produced. An alum crystal growing in a labile solution is surrounded by a zone of metastable liquid which prevents it from starting the network (*c*) characteristic of a labile drop. Experiments were made upon the action of various mineral substances in inducing crystallisation in metastable and labile drops. Among these the holosymmetric cubic crystals, and especially galena, exercise a remarkable effect in producing the network (*c*) in labile drops.—Note on the Formation of Gypsum Crystals in a disused Well at Chemical Works, by C. J. Woodward. Groups of gypsum crystals were exhibited which were found thirty years ago studding the walls of an old well at Messrs. Chance's Chemical Works at Oldbury.—Notes on Minerals recently found in the Binnenthal, by Mr. R. H. Solly. The minerals described were: (1) Ilmenite, in brilliant crystals, displaying marked hemihedrism and showing five new forms. It is associated with quartz, adularia, magnetite, and mica, on mica-schist. (2) Seligmannite; an exceptionally large and well-developed crystal in dolomite. Unlike any previously described, it is untwinned; altogether 45 forms were observed, of which 21 are new. (3) Marrite; two more crystals of this rare mineral were found, one tabular and the other sharply pointed in habit. (4) Proustite; a minute crystal deposited on a crystal of rathite. (5) Trechmannite; a crystal of this rare mineral displaying asymmetric hemihedrism, deposited on a crystal of binnite. (6) Hyalophane, in crystals of an unusual green colour.

CORRESPONDENCE.

THE AGE OF 'THE MOUNT TORLESSE ANNELID.'

SIR,—In my paper on these fossils (GEOL. MAG., Dec. V, Vol. II, pp. 532–541; December, 1905) it was said that the beds containing them were "usually regarded as the uppermost division of the Maitai Series"; but the stratigraphical position of that series was treated as an open question, though "probably not below Upper Carboniferous and not above Trias." The paper was unfortunately written without reference to a valuable series of articles by Professor James Park, of Otago University, contained in the *Transactions of the New Zealand Institute*, vol. xxxvi. From these papers it appears that "a good deal of doubt must attach to the determinations" of the fossils found by Mr. M'Kay in the Maitai Limestone; the fossils collected by Professor Park in the same bed are identified by him as "*Spiriferina* (two sp.), *Athyris*, *Rhynchonella*, *Pleurotomaria*, *Inoceramus*, *Pentacrinus* [presumably *Isocrinus*], and corals (three sp.)." These, as well as other fossils in corresponding beds, indicate that the limestone in question, so far from being Lower Carboniferous, is really Upper Triassic. On this ground alone the conformably succeeding shales, etc., would probably be of Jurassic age. Further, the "shell like *Inoceramus*" alluded to on pp. 535, 536 of my paper, is regarded by Professor Park as *Inoceramus* itself, and as indubitable proof of Mesozoic age. The Maitai shales, etc., of the Nelson district are correlated by Professor Park with the Mataura formation of Otago, and since the name 'Maitai' has become so ineradicably associated with the idea of Carboniferous age, he adopts Hutton's 'Mataura Series' with its familiar Jurassic connotation. He further adopts Hutton's 'Hokonui System' to include the Mataura Series and the conformably underlying Shaw's Bay Series of Triassic (and ? Permian) age.

The Mount Torlesse Annelid beds are mentioned by Professor Park on p. 392, only to say that "in the absence of shell beds it is impossible to fix the position of the plant and annelid beds in relation to known horizons elsewhere . . . . the strata at Mount Torlesse do not afford the data necessary for their subdivision into groups and series of beds." It seems, however, to result from Professor Park's work that the horizon of *Torlessia Mackayi* and *Dentalium Huttoni* is "not below Trias and not above Jurassic." Perhaps it would be permissible to say "probably Lias"; and here one recalls that the Yakutat slates with *Terebellina* are also probably Lias.

To Professor Park and to readers of the GEOLOGICAL MAGAZINE an apology seems necessary for the omission of the preceding remarks from my original paper. Their omission was due mainly to the fact that the volume containing Professor Park's articles, though issued in August, 1904, has not yet been received either by the British Museum (Natural History), "to whom this volume is

presented by the Governors of the New Zealand Institute," or by the Science Library of the Education Department, which has been attempting to procure it through the usual agents. My attention was drawn to it by Dr. Wilckens' excellent abstracts in *Neues Jahrbuch für Mineralogie*, 1905, II, which reached England after my paper had gone to press. It is intelligible that Professor Park should send his fossils to Freiburg for determination; but it is hard that British palæontologists, who at least try to do their best, should have to learn of the admirable work of their New Zealand brethren from a German publication.

F. A. Bather.

December 5th, 1905.

THE SEPARATE EXISTENCE OF GEOLOGY AS A SCIENCE.

Sir,—I observe in the Anniversary Address of the President of the Geological Society (John Edward Marr), 17th February, 1905, p. xi, the following paragraph:—"It is not wonderful that in these circumstances there appears to be a feeling among some that geology as a separate science will become extinct." I have met with statements somewhat akin to this which have drawn my attention to the subject. Geology is the history of the earth, and therefore includes all other sciences and all natural knowledge (except the abstract sciences). Therefore, if geology as a science is to become extinct it can only be as regards the name (unless, indeed, it is meant that the human race is to become extinct), for as long as a reasoning being exists on the earth there must be some kind of a history of the earth. Astronomy, biology, mineralogy, etc., are merely branches of this science.

I would remark also on a statement in the Address of H. A. Miers to the Geological Section of the British Association in South Africa, wherein he says he has no claim to be called a geologist. If a man who has a profound knowledge of some departments of geology, and, it may be presumed, a good general knowledge of geology likewise, is not to be called a geologist, then who is?

R. J. Lechmere Guppy.

Port of Spain, Trinidad.

MESSRS. HATCH & CORSTORPHINE'S "GEOLOGY OF S. AFRICA."

Sir,—It may prevent some confusion subsequently, to point out that in Hatch & Corstorphine's recently-issued work on "The Geology of South Africa" there is an error in the naming of one of the fossils from the Umtamvuna Series (Pondoland) depicted in fig. 71 on p. 259. Fig. 71*b* should have been described as *Ammonites gardeni*, and not *Ammonites soutoni*, the figure having evidently been copied from one of Baily's original figures of that species (Quart. Journ. Geol. Soc., vol. xi, 1855, pl. xi, fig. 3*a*).

British Museum (Natural History). G. C. Crick.